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An Analysis of Alternative Policies for Dealing with New Source Growth in Nonattainment Areas: Oxides of Nitrogen Study Area: Philadelphia AQCR

Engineering-Science, Inc.
McLean, VA

Prepared for

Environmental Protection Agency
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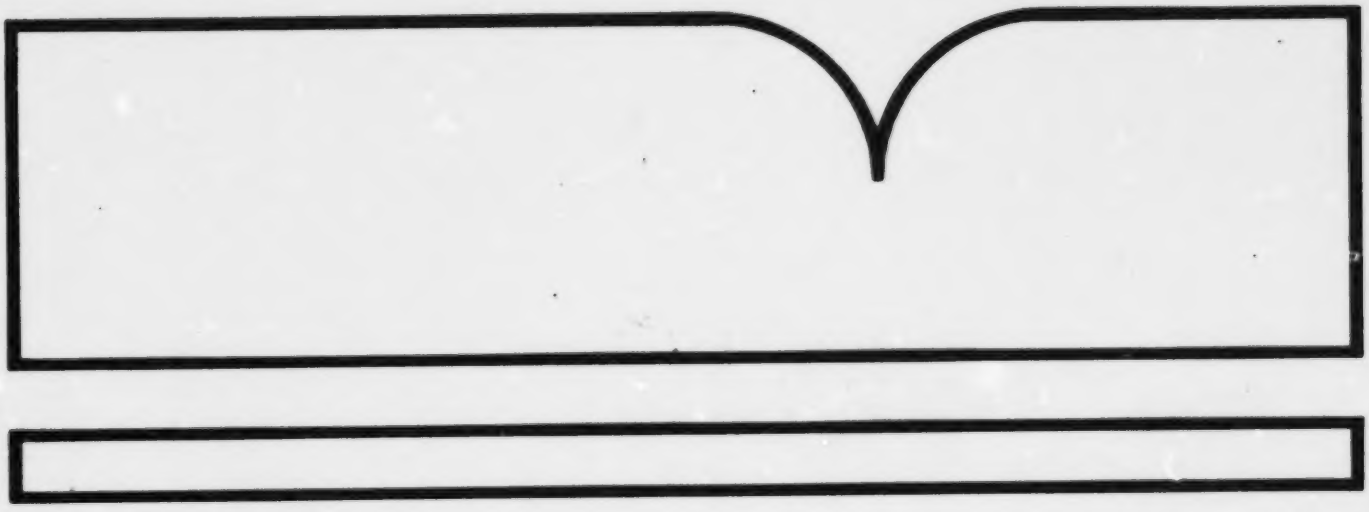

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This study evaluates the potential of five air pollution control strategies to meet Oxides of Nitrogen (NO_x) attainment deadlines in Philadelphia. The scenarios analyze: 1) pre-1979 regulations, 2) A State Implementation Plan (SIP) based on Reasonable Available Control Technology (RACT), 3) A RACT SIP which requires emission offsets for new sources, 4) A RACT SIP which allows no major source construction after 1979, and 5) A SIP which bans construction after 1979 and requires existing sources to retrofit with Lowest Achievable Emissions Rate (LAER) technology.

The study's major conclusions 1) Demonstration of reasonable further progress is likely by 1982 and will not require a reduction in anticipated source growth, 2) Major point sources continue to dominate the emissions picture after 1982, and 3) RACT controls on point sources ensure attainment by 1990.

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Oxides of Nitrogen

STUDY AREA: Philadelphia AQCR

Submitted to

U.S. Environmental Protection Agency
Office of Planning and Evaluation
Washington, D.C.

March 1980

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AN ANALYSIS OF ALTERNATIVE POLICIES FOR DEALING WITH NEW SOURCE GROWTH IN NONATTAINMENT AREAS

OXIDES OF NITROGEN

STUDY AREA: PHILADELPHIA AQCR

Submitted to

U.S. Environmental Protection Agency
Office of Planning and Evaluation
Washington, D.C.

Submitted by

Engineering-Science
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March 1980

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CHAPTER I

INTRODUCTION

This study was requested by the U.S. Environmental Protection Agency (EPA) as a result of congressional and executive mandates to evaluate policies dealing with nonattainment of the National Ambient Air Quality Standards (NAAQS).[1,2] It is one of several studies in major metropolitan areas which seek to illuminate the potential conflict between public health goals and socio-economic interests so that conflict may be avoided or dealt with equitably. The issue is how best to handle potential new source construction in areas currently exceeding the NAAQS while ensuring expeditious attainment of the public health standards in a fair and effective manner.

Pursuant to Section 107(d) of the Clean Air Act, as amended 1977, the Commonwealth of Pennsylvania designated attainment/nonattainment areas on December 5, 1977. The U.S. EPA published the list of attainment/nonattainment areas for Pennsylvania in the Federal Register, Vol. 43, No. 43, dated March 3, 1978. For oxides of nitrogen (NO_x), neither the City of Philadelphia nor any of the surrounding counties which comprise the Greater Philadelphia Metropolitan Area (including counties in New Jersey and Delaware) were cited as nonattainment. These designations were based on data obtained during the period 1975 through 1977. However, since that time, more recent NO_x data for the City of Philadelphia indicate violations of the NO_x air quality standard.

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1 The President's Environmental Message directed EPA to "review the current regulations controlling the construction of new facilities in areas not yet attaining air quality standards to ensure that these regulations will not interfere with the expeditious attainment of air quality levels required to protect public health. EPA is instructed to recommend a fair and effective policy for meeting these standards in the future".

2 H.R. 6161 directed the Administrator and National Commission on Air Quality separately to report to Congress on the "air quality health, welfare, economic, energy and social effects" of the current Congressional, EPA and alternative policies to deal with this issue. In the Conference Bill this study provision for a further evaluation of the nonattainment problem appears as one of the required reports of the National Commission on Air Quality.

For those previously mentioned counties surrounding Philadelphia, current data indicate continuing healthful NO_x levels.

Since a potential NO_x attainment problem may exist in the Philadelphia Air Quality Control Region (AQCR), it was assumed that a revision of the State Implementation Plan (SIP) may be necessary. This report describes the types of alternatives analysis which may be necessary and the amended Clean Air Act requirements which would apply if a NO_x nonattainment problem is identified in the Philadelphia AQCR.

The primary purpose of this study was to evaluate the policy alternatives which might be considered in addressing a potential NO_x nonattainment problem in the Philadelphia AQCR. It was not intended to substitute for the more detailed planning and analysis which the state air agency may be required to conduct in preparing the SIP. However, the analysis is a simulation of what the Pennsylvania Department of Environmental Resources might have to perform in developing strategies to further reduce emissions in the Philadelphia metropolitan area.

A complete air quality study for the Philadelphia metropolitan area is summarized in three volumes. Volume I is an analysis of policy alternatives and their impact on ozone concentration levels; Volume II presents a parallel analysis for total suspended particulate (TSP); and Volume III (this volume) assesses the potential oxides of nitrogen (NO_x) problem.

The remainder of this chapter summarizes the study approach and the assumptions and limitations of the study, discusses the methodology used in the analyses, and describes the policy options considered. In addition, the report consists of five other chapters. Chapter II presents the conclusions of the study regarding attainment of the NO_x NAAQS. Chapter III discusses the data used in the analysis, its origin, and the interpretations that were made in order to use it in this study. Chapter IV summarizes the estimated reductions in NO_x emissions required to demonstrate attainment of the standards and achieve the reasonable further progress guideline of the Clean Air Act Amendments. Chapter V presents the impacts of the policy studies. Detailed documentation, calculations, and original data used in the study are presented in appendices to facilitate reading.

DESCRIPTION OF THE STUDY AREA

EPA chose three representative "nonattainment" cities for the studies--Philadelphia, Chicago, and Houston. The Philadelphia area was selected for use in this analysis because it represents a major city in the northeastern U.S. which is expected to have a low growth rate and it's industrial mix differs from that of Houston or Chicago. Although emissions and air quality data were collected for the entire AQCR, the effort put forth in this study had most concern with Philadelphia County because the potential nonattainment problem exists there.

Urban Character

The Metropolitan Philadelphia Interstate AQCR is a mature manufacturing complex sprawling along the Delaware River from its mouth in Delaware Bay northeastward to the great bend at Trenton. It comprises 11 counties in three states; Bucks, Chester, Delaware, Montgomery, and Philadelphia Counties, Pennsylvania; Burlington, Camden, Gloucester, Mercer, and Salem Counties, New Jersey; and New Castle County, Delaware. The area comprises AQCR No. 045 and is shown in Figure I-1. Deep water ports are found in Wilmington, Philadelphia, Camden, and Trenton. In addition, the Schuylkill River is navigable for about 6.5 miles north of its confluence with the Delaware. The urban core lies along the rivers with population density and manufacturing-commercial activity diminishing with distance from the Delaware River and merging with agricultural activity in the outermost fringes of all counties except Philadelphia County. The population in the 11-county area in 1975 was estimated to be 5,644,029.[1,2,3]

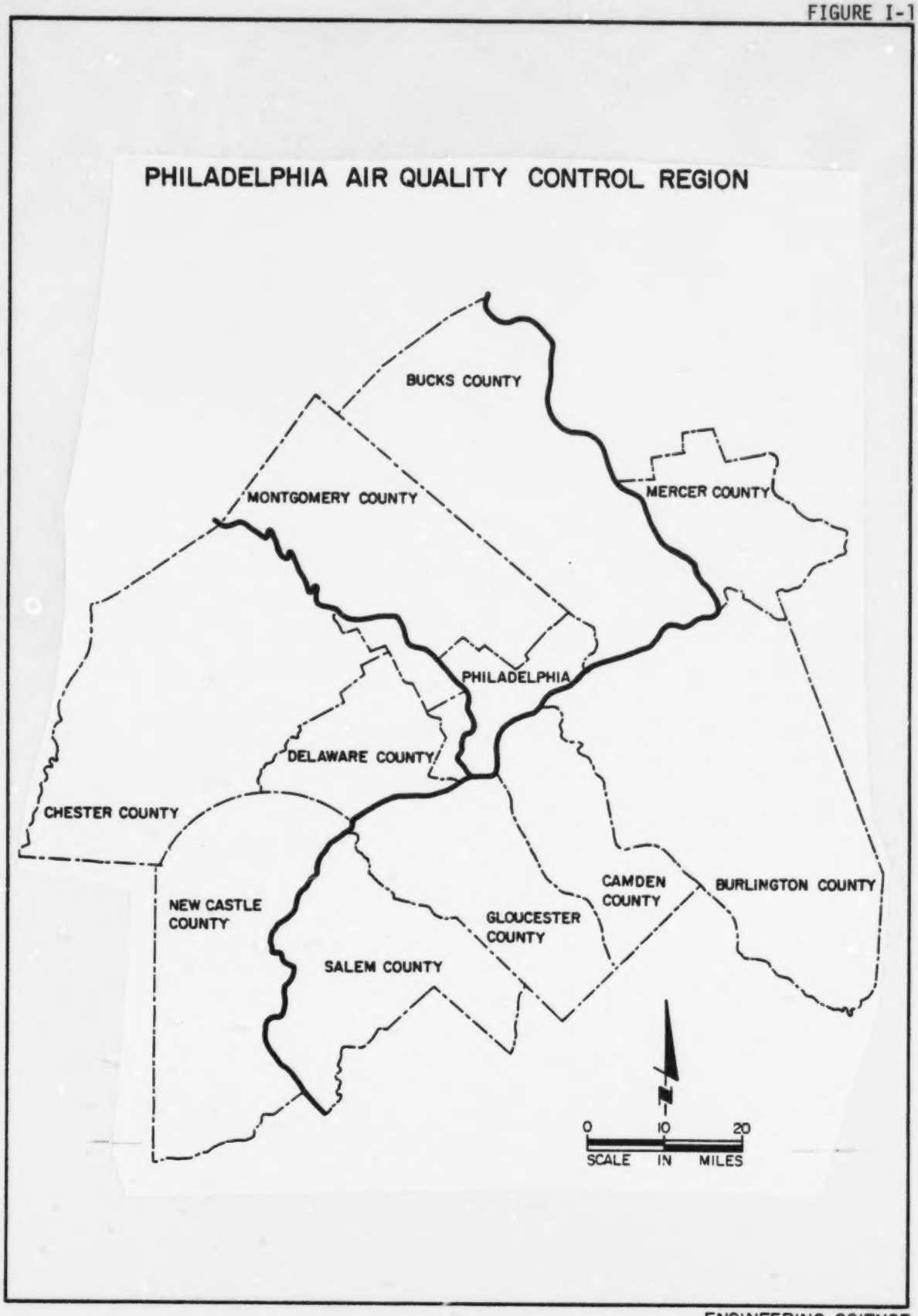
---

[1] Delaware Valley Data, No. 15, April 1977. Delaware Valley Regional Planning Commission.

[2] Population Estimates for New Jersey, Office of Business Economics, Dept. of Labor and Industry, P.O. Box 845, Trenton, NJ 08625.

[3] Delaware Population Growth: 1975 Estimates and Projections to 1995 for the State and Major Civil Divisions, N.W. Rives, Jr. and C.H. Brown, Div. of Urban Affairs, University of Delaware, October 1975.

FIGURE I-1


PHILADELPHIA AIR QUALITY CONTROL REGION
BUCKS COUNTY
MONTGOMERY COUNTY
MERCER COUNTY
PHILADELPHIA
DELAWARE COUNTY
CHESTER COUNTY
NEW CASTLE COUNTY
SALEM COUNTY
GLOUCESTER COUNTY
CAMDEN COUNTY
BURLINGTON COUNTY
N
0 10 20
SCALE IN MILES

Population growth during the decade of the 1960's was on the order of 12 percent, most of which occurred in the suburban fringe. The urban core actually declined slightly in population in this interval (-2.7 percent). Manufacturing and commercial activity have experienced a similar migration with nodes forming around shopping center malls. Meanwhile, the urban core activity has undergone a gradual transition from manufacturing toward increased highly specialized services: government, finance, business, health, and education.

For some time, the area has been a trade and distribution center. The area is still a travel crossroads for all modes. The Delaware River, which is the prinicpal axis of the urban area, is active with both domestic and foreign trading vessels; rails radiate from the axis in all directions; the Pennsylvania Turnpike, the New Jersey Turnpike, the Schuylkill Expressway, and Interstate 95 are major movers of motor vehicular traffic through the area; and major airports serve the area at Wilmington, Philadelphia International, and North Philadelphia.

Air Quality

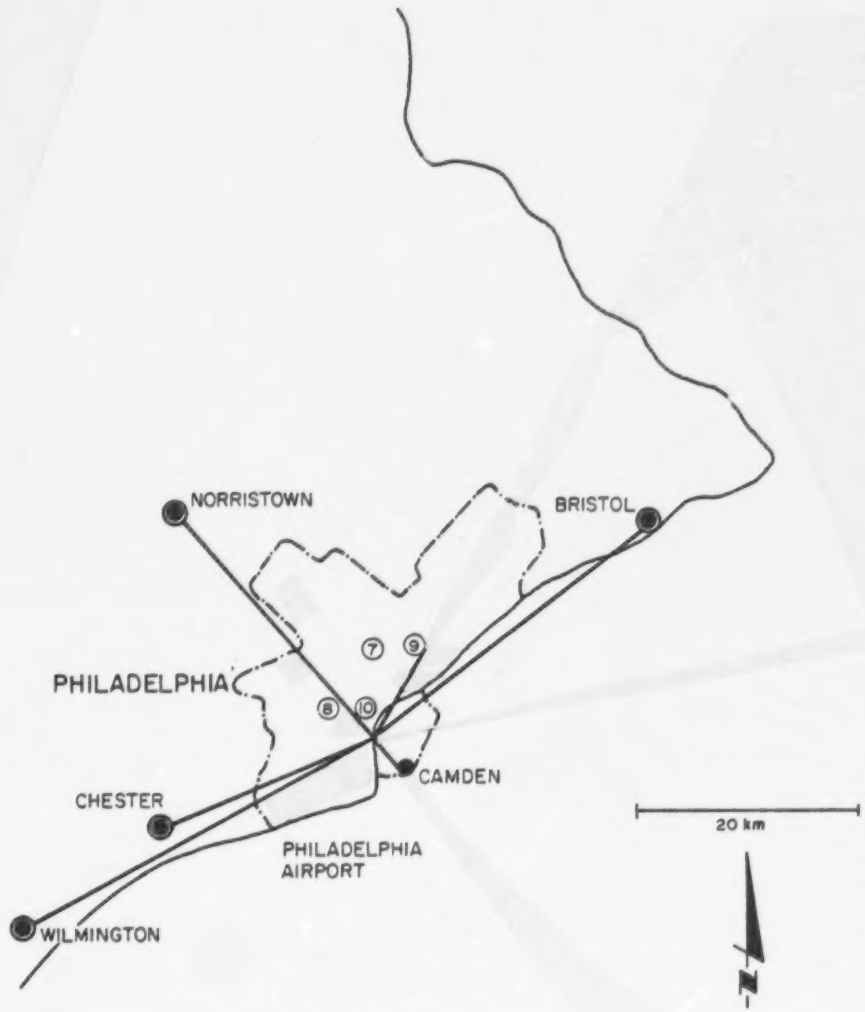
As previously mentioned, current ambient air NO_x concentrations exceed the NAAQS of 0.05 pm, annual average mean. Nine monitoring stations are maintained by three state air agencies around the urban core as shown in Figure I-2. Except for two stations, ambient NO_x data obtained from this metropolitan monitoring network indicate attainment of the NO_x NAAQS.

The two exceptions are located in Philadelphia in the northern and southern portions of Broad Street. Recent data indicate NO_x concentrations as high as 0.056 ppm at these two locations. Ambient levels in the remainder of the AQCR average approximately 0.03 ppm, annual arithematic mean. Appendix A includes a more detailed discussion of the monitoring network and recent NO_x data.

Growth Trends

The Delaware Valley Regional Planning Commission (DVRPC) suggests moderate growth will take place on a regional basis clustered around existing nodes. Their population projections over the 1970-2000 interval show an

AIR QUALITY MONITORING NETWORK *



* The air quality monitoring network around the Philadelphia AQCR Numbered Sites are urban core sites maintained by Philadelphia AMS.

an increase of only 16%; employment projections show an increase of 27%.[1] Specific industry forecasts, however, are needed for a study such as this and reliable forecasts were difficult to obtain. Appendix B describes the wide range of growth projections obtained and the manner of selecting those used in the study.

DESCRIPTION OF THE METHODOLOGY

In this study, proportional modeling has been used to estimate the changes in NO_x levels resulting from implementation of the various alternative schemes in Philadelphia. The emission inventory and ambient air quality data necessary for the study were obtained from several state environmental agencies and esti-estimates of growth rates for major new and existing industrial sources were obtained from a number of planning agents. Industrial growth was allocated to the Philadelphia area based on the growth of industrial production in the AQCR. In order to estimate replacement rates, i.e., those schedules by which existing sources would be retired because of normal fatigue and wear, useful life allowed for tax purposes was obtained from the Internal Revenue Service.

Definitions of control technology were not developed for this study. Instead, assumptions were made regarding the level of NO_x control that could be applied to new and existing point sources to determine future emissions. These assumptions were based on data from several references, from other EPA contractors, and from discussions with EPA's Office of Air Quality Planning and Standards. Considerable effort was made to collect all of the data available. Control technology guidelines (CTGs) have not been issued by EPA to indicate what is considered reasonably available control technology (RACT). It was felt that state and local control officials have a great deal of knowledge as to the types of controls that can effectively be put on various NO_x emission sources. This is indeed true when considering emissions from major point sources.

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1 Year 2000 Regional Development Guide Data Bank for Transportation Planning, Tech. Report No. 3, Delaware Valley Regional Planning Commission, September 1977.

The base year used in this analysis was 1976. Two future years, 1980 and 1990, were used for projections of emissions and air quality. The results were analyzed for 1982, a key attainment data required in the Clean Air Act Amendments of 1977. In order to assure that the NO_x standard would be maintained after 1982, the analysis also covered the period through 1990.

In order to relate NO_x emissions in Philadelphia and their subsequent impact on air quality, a simple proportional model or "rollback" was used for this study. This technique was used to demonstrate attainment of the nitrogen dioxide NAAQS. Emissions for the base year and projected 1982 were included in the model along with maximum and background ambient air NO_x values to determine necesssary NO_x reductions and/or attainment status. A background NO_x level was determined based on historic ambient NO_x concentrations monitored at rural locations. Since the proportional modeling technique was used, meteorological data were not required for the analysis.

Primary attention in this analysis was given to the demonstration of attainment of the annual nitrogen dioxide standard, 0.05 ppm, in the City of Philadelphia. A cursory analysis of "reasonable further progress" as required the amended Clean Air Act was also completed.

THE 1977 CLEAN AIR ACT REQUIREMENTS FOR NO_x

The relevant requirements for nonattainment areas as set forth in the 1977 Clean Air Act Amendments can be summarized in four basic categories:

1. Reasonably available control measures;
2. Demonstration of attainment by 1982;
3. Reasonable further progress; and
4. Mechanisms for handling and tracking major source growth.

Reasonably Available Control Measures

The 1970 Clean Air Act required states to develop SIPs to attain and maintain national ambient air quality standards. These plans established emission limitations and requirements as necessary to meet standards by the specified attainment dates. In nonattainment areas, the SIPs must now be submitted in early 1979 so that EPA can approve them by July 1, 1979. These revised plans are required to impose measures representing reasonably available control technology (RACT) on all stationary sources. Under no circumstances can the attainment of the NO_x standard be extended beyond the December 31, 1982 deadline.

Demonstration of Attainment by New Stationary Attainment Dates

National ambient air quality standards must be attained as expeditiously as practicable. The 1977 Clean Air Act Amendments extended the statutory attainment dates to December 31, 1982 for all pollutants except photochemical oxidants (ozone) and carbon monoxide. Congress recognized the difficulty that areas with problems related to these two pollutants would have in demonstrating attainment by the earlier data. In each case, an additional five years (attainment by December 31, 1987) may be permitted.

Sanctions

If a state is unable to submit a SIP that can demonstrate attainment of national standards and which can be approved by EPA, specific sanctions may be invoked under the Clean Air Act. These restrictions include no major construction after July 1979 and limitations on Federal funds for highways and wastewater treatment facilities.

Reasonable Further Progress

Prior to the attainment of the standards, the Clean Air Act Amendments require interim progress in emission reductions on an annual basis, preferably in equal annual emission reductions which will provide for attainment by the statutory date. There is an explicit requirement in the Act that, to the extent possible, these reductions should be realized in the early years.

Mechanism for Handling Major Source Growth

Growth must take place within the framework of a plan which will achieve health based standards.

Prior to July 1979, the EPA offset ruling is in effect. There are two key conditions to the offset ruling:

- For every ton of emissions from a new source, there must be an offsetting emission reduction from existing sources sufficient to represent reasonable further progress toward attainment; and
- The new source must meet the lowest achievable emission rate (LAER) which is the lowest rate achieved in practice or the lowest emission limitation set forth by any SIP for that same class or category of sources.

After July 1979, states are given a choice of two options as to how to handle new growth. The state can either:

- o Create a quantitative margin for growth within the state implementation plan by imposing emission limitations on existing sources to a greater degree than minimally necessary to meet standards; or
- o Continue some form of case by case emission offset approach.

In many cases, the states will provide for a combination of both approaches. With either option, new major sources must meet the lowest achievable emission rate.

As will be discussed below, the first of these requirements, reasonable available control measures is assumed to be part of each of the policy options under study. The fourth element under the Clean Air Act Amendments, mechanisms for handling new major source growth will vary amongst the policy options. The second and third elements of the 1977 Clean Air Act Amendments are used to evaluate each policy option in light of its ability to meet these two requirements: reasonable further progress and demonstration of attainment by the new statutory date. In order to evaluate the extent to which policy options meet these two criteria, these requirements are interpreted with respect to current EPA policy in general and how they apply to the case study area in particular.

DESCRIPTION OF POLICY OPTIONS

The various policy alternatives examined in the study included:

- o A base Case Analysis;
- o Four Key Policy Option Analyses; and
- o Several Sensitivity Analyses.

A number of assumptions were made regarding the various levels of control and growth. The policy options were selected to represent the full range of impacts and were not intended to represent real policy choices under active consideration. For these analyses, the evaluations were made as realistic as possible. For all policy options examined, offsets were neither assumed to be required nor obtained during the period 1977 through 1979 in the Philadelphia AQCR. However, for the "no-growth" policies considered, growth was assumed to be curtailed after 1979 since a potential NO_x problem exists in Philadelphia.

For the base case and each of the four policy options analyzed, a control technology level was assigned to each of the emission source categories (Table I-1). Major sources were separated into three separate groups: existing, new, and replacement. Mobile sources were addressed separately and included all road vehicles (such as cars, trucks, motorcycles, and buses) and other mobile sources such as off-road vehicles, airplanes, ships, boats, and rail locomotives. Minor stationary point and other area sources were aggregated into the remaining source category.

The base case and the four policy options are defined in more detail in the ensuing discussion.

Base Case: Pre-1979 SIP with Major Source Construction

A base case analysis was first performed to illustrate the potential impacts if a SIP were not developed and major source construction took place using LAER or proposed New Source Performance Standards (NSPS) controls. For this analysis, it was assumed that growth would continue for all source categories except major or modified new stationary sources because an NO_x SIP has not been developed. The following assumptions were made for the base case analysis for each of the source categories:

- Major New Stationary Sources - Growth was projected with LAER controls and no offsets were required.
- Major Existing Stationary Sources - Growth was projected to continue.
- Minor and Area Stationary Sources - Growth was projected to continue.
- Mobile Area Sources - Growth was projected to continue with controls from the current Federal Motor Vehicle Control Program.

Policy Option: RACT SIP with Major Source Construction

This policy assumed that all existing major point sources were required to meet RACT controls through SIP regulations. All major new source construction was required to take place using LAER controls and no offsets were required. The following assumptions were made for each of the source categories:

TABLE I-1

CONTROL TECHNOLOGY ASSUMPTIONS USED FOR POLICY ANALYSES

POLICY OPTIONS	MAJOR			MINOR[1]	MOBILE
	EXISTING	REPLACEMENTS	NEW	AREA	AREA
Pre-1979 SIP with Major Source Construction	SIP[2]	LAER	LAER	UNC	FMVCP
RACT SIP with Major Source Construction	RACT	LAER	LAER	UNC	FMVCP
RACT SIP with Offsets for Major Source Construction	RACT[3]	LAER	LAER	UNC	FMVCP[3]
RACT SIP with No Major Source Construction after 1979	RACT	LAER	N/A	UNC	FMVCP
LAER Replacement with No Major Source Construction after 1979[4]	LAER	LAER	N/A	UNC	LAER[5]

1 Existing 1976 Emissions plus Growth (uncontrolled emissions).

2 SIP was assumed to correspond to existing 1976 emissions plus growth.

3 In order to provide offsets, these source categories may be further reduced beyond the RACT SIP. Existing major sources would reduce to LAER and mobile sources would reduce to a 20% transportation control plan.

4 This scenario assumed that all existing sources were controlled to the maximum possible levels.

5 In addition to FMVCP limits, assumes a 20% transportation control plan.

- Major New Stationary Sources - Growth was projected with LAER controls and no offsets were required.
- Major Existing Stationary Sources - Production was limited to 1976 levels and sources were retrofitted with RACT level controls.
- Minor and Area Stationary Sources - Growth was projected to continue.
- Mobile Area Sources - Growth was projected to continue with controls from the current Federal Motor Vehicle Control Program.

Policy Option: RACT SIP with Offsets for Major Source Construction

This policy assumed that all existing major sources were required to meet RACT controls through SIP revision regulations. All major new source construction met LAER controls and obtained offsetting emission reductions. The available pool of offsets included emission reductions from existing sources to RACT levels only until the promulgation of a revised SIP. Later, existing sources were assumed to be controlled to the LAER level, thus providing additional offsets. For simplicity of analysis, it was assumed that the offset pool was fully tradeable and that such emission reductions could be carried over (banked) until needed.

The following assumptions were made for each of the source categories:

- Major New Stationary Sources - Growth was projected with LAER controls and offsets were required from 1980 through 1990.
- Major Existing Stationary Sources - Production was limited to 1976 levels and sources were retrofitted first with RACT level controls and later for the purpose of providing offsets with LAER controls.
- Minor and Area Stationary Sources - Growth was projected to continue.
- Mobile Sources - Growth was projected to continue with controls from the current Federal Motor Vehicle Control Program.

Policy Option: RACT SIP with No Major Source Construction after 1979

This policy option attempted to demonstrate the effect of curtailing all major source construction and controlling existing sources with RACT technology. Although mobile sources were permitted to maintain the projected growth rate in vehicle-miles-traveled, emissions were expected to decrease because of turnover to less polluting vehicles. The following assumptions were made for each of the source categories:

- o Major New Stationary Sources - No major source construction.
- o Major Existing Stationary Sources - Production was limited to 1976 levels and sources were retrofitted with RACT level controls.
- o Minor and Area Stationary Sources - Growth was projected to continue.
- o Mobile Sources - Growth was projected to continue with controls from the current Federal Motor Vehicle Control Program.

Policy Option: LAER Replacement with No Major Source Construction after 1979

This scenario was more hypothetical than the others. It assumed that all existing sources were replaced over time with new sources having the same production capacity but using LAER control technology. No net growth of major source capacity was allowed. The following assumptions were made for each of the source categories:

- o Major New Stationary Sources - No major new source construction.
- o Major Existing Stationary Sources - Production was limited to 1976 levels and sources were retrofitted with LAER level controls.
- o Minor and Area Stationary Sources - Growth was projected to continue.
- o Mobile Area Sources - Growth was projected to continue with LAER level controls (20% transportation control plan).

SENSITIVITY ANALYSIS

Several sensitivity analyses were conducted to determine the impact of the input variables on subsequent findings and conclusions. These included determining the potential for attainment using the following tighter controls on existing point sources:

- o RACT controls
- o LAER controls
- o Controls in the AQCR rather than in the nonattainment area

Each of these analyses, testing the sensitivity of some of the input variables was examined to determine whether the outcome of any of these policy options or scenarios studied would be effective. Furthermore, some of these analyses may be used to further refine or modify policies dealing with new source growth in nonattainment areas.

CHAPTER II

SUMMARY AND CONCLUSIONS

An analysis was made of several policy options related to industrial growth in the Philadelphia AQCR, which may not presently attain the nitrogen dioxide standard. An emission inventory was compiled for major point sources, stationary minor and area sources, and mobile sources. Emissions from external combustion and mobile sources dominated the total emissions for this area. The current EPA methodology for demonstrating attainment of the NO_x standard called for the use of modeling. A proportional NO_x model was used in this analysis to relate the changes in emissions which are expected under the various policy options and their subsequent impact on ambient air quality.

The NO_x design value used in the analyses was 0.056 ppm which establishes a required NO_x emission reduction of 12% to attain the 0.05 standard if the rollback method of estimation is used. The Pre-1979 SIP cannot bring attainment (since such a SIP does not presently exist for NO_x) and nonattainment by 1982, with continued growth, was assumed in the City of Philadelphia.

In order to achieve reductions in NO_x emissions, assumptions were made on the level of control that could be applied to major point and mobile sources in the City of Philadelphia. The so-called RACT and LAER control technology definitions used in this study were developed from literature searches and reviewed by EPA's ESED.

After establishing the base or "no action" case, the study considered: a RACT SIP, a RACT SIP with emission offsets, a RACT SIP with no major construction, and a LAER SIP with no major construction. These policies represent the range of options which could be available for control officials in meeting the Clean Air Act Requirements and for attaining the NO_x standard no later than December 31, 1982. The study period was 1976 through 1990, focusing on the question of reasonable further progress in the period 1979 to 1982 and attainment by 1982.

INTERIM PERIOD 1979 THROUGH 1982

1. Concerning attainment by 1982, all options achieved greater reduction in the City of Philadelphia than required by the rollback estimate (12%).

The range in reduction achieved was substantial, ranging from 20% for the RACT SIP to 37% for the more stringent LAER scenario.

2. All options were easily below the emission levels required to show reasonable further progress toward attainment by 1982.
3. The results of the study were found to be quite insensitive to: changes in the base year emission inventory or background values, growth at a much greater or smaller rate, and improvements in control technology.
4. Not only can all anticipated source growth anticipated under the scenarios be accommodated, the RACT and LAER scenarios (the policy option extremes) could provide an additional 7,000 and 20,000 tons per year of new growth, respectively, and still attain the NO_x air quality standard.
5. If the air quality impact attributable to mobile source emissions at the maximum monitoring site is greater than the estimated 16 ppb, it is possible that additional controls on NO_x sources may not be necessary. This is due to the fact that emissions reductions from the mobile source sector, resulting from vehicle turnover and the associated FMVCP, will be realized in future years. If the air quality decreases from these reductions are more than the additional air quality impacts due to growth in other source categories, attainment may be possible without controls.
6. The key to demonstrate attainment by 1982 in the Philadelphia area lies with the control of existing point sources. If tighter controls were assumed for these two categories then it is possible that a RACT SIP could demonstrate attainment by 1982.

1983 THROUGH 1990

1. Major point sources will continue to dominate the emissions picture after 1982. If RACT controls were adopted and installed on point sources, projected air quality levels would not exceed the NO_x ambient air standard in 1990.

2. With assumed growth under the RACT SIP policy option, air quality improves in the period 1983 to 1990. As previously mentioned, this is attributable to the FMVCP off-setting emission increases from stationary sources.

3. In sum, the potential for attaining and maintaining the NO_x air quality standard in the Philadelphia AQCR lies with the control of existing point sources. If such controls can be adopted and implemented in a timely fashion, this area can achieve NO_x standards.

CHAPTER III

DATA INPUTS USED FOR ANALYSES

This chapter provides a summary of the data used to conduct the policy analyses for this study. The data were comprised of four basic elements:

- o emission inventories;
- o control technology definitions;
- o growth projections; and
- o replacement rates of production facilities.

The appendices of this report contain additional detailed information concerning the methodologies and sources of information which were used in compiling each data base.

The purpose of this chapter is to briefly describe the methodology used to develop the NO_x emission sources, identify how the inventories were used in the analyses, and focus on the key elements affecting the policy analyses. Each of the above data bases is discussed separately. Additionally, a SIP allowable discussion addresses the baseline emission inventory used to the analyses.

EMISSION INVENTORIES

For this analysis, the NO_x emission inventory was divided into three categories:

- o major point sources;
- o stationary area sources; and
- o mobile sources.

A complete definition of each category and the specific methodology used to tabulate NO_x emissions for the Philadelphia AQCR are included in Appendix C. In general, the point source emission inventory was based on data supplied by Philadelphia Air Management Services, Delaware Department of Natural Resources and Environmental Control, and New Jersey Department of Environmental

Protection. Additional data generated from questionnaires was obtained from the Pennsylvania Department of Environmental Resources. An existing 1974 area source inventory prepared by GCA for EPA Region III was updated to 1976. An inventory of emissions from highway vehicles was developed based on traffic data supplied by the Delaware Valley Regional Planning Commission. Off-highway vehicle emissions were inventoried based on activity levels derived for the nonmethane hydrocarbon emissions inventory prepared for the Philadelphia AQCR.

Major Point Sources

A summary of the NO_x point source emission inventory (actual 1976 emissions) used in this study is presented in Table III-1 and is defined in terms of six general industrial categories. Emissions of NO_x were highest from the electric utility industry. Of the total 155,485 tons per year of NO_x emitted from all major point sources, 89,472 tons per year (58%) came from the electric utility category. Emissions from industrial boilers accounted for 36,127 tons per year or 23% of the total for major point sources.

As mentioned above, the major point source NO_x emissions totaled 155,485 tons per year of 48% of all NO_x emissions in 1976. Figure III-1 illustrates the relative importance of the various industrial categories comprising the major point sources and Appendix C contains a summary of NO_x emissions by county.

Table III-1 also illustrates the effect of applying RACT type controls to the base year major point source emissions. This represents a hypothetical case. If RACT type controls were applied, emissions would be 87,762 tons per year, a 43% reduction in emissions. If LAER type controls had been applied to the sources that were operating in 1976, emissions would have been 58,017 tons per year representing a 63% reduction in the base year point source emissions.

Finally, Table III-1 illustrates the effect of additional point source growth anticipated for the Philadelphia AQCR. By 1990, an additional 9,050 tons per year of NO_x (a 6% growth over the base year 1976 emission conditions) will be emitted. For 1982, the expected growth from new sources is 3,878 tons per year or a 2.5 percent growth of NO_x emissions from the 1976 levels.

The effect of applying RACT and LAER type controls to the projected 1990 major point source NO_x emissions has also been determined. Again, this represents a hypothetical case. If RACT type controls were applied, emissions

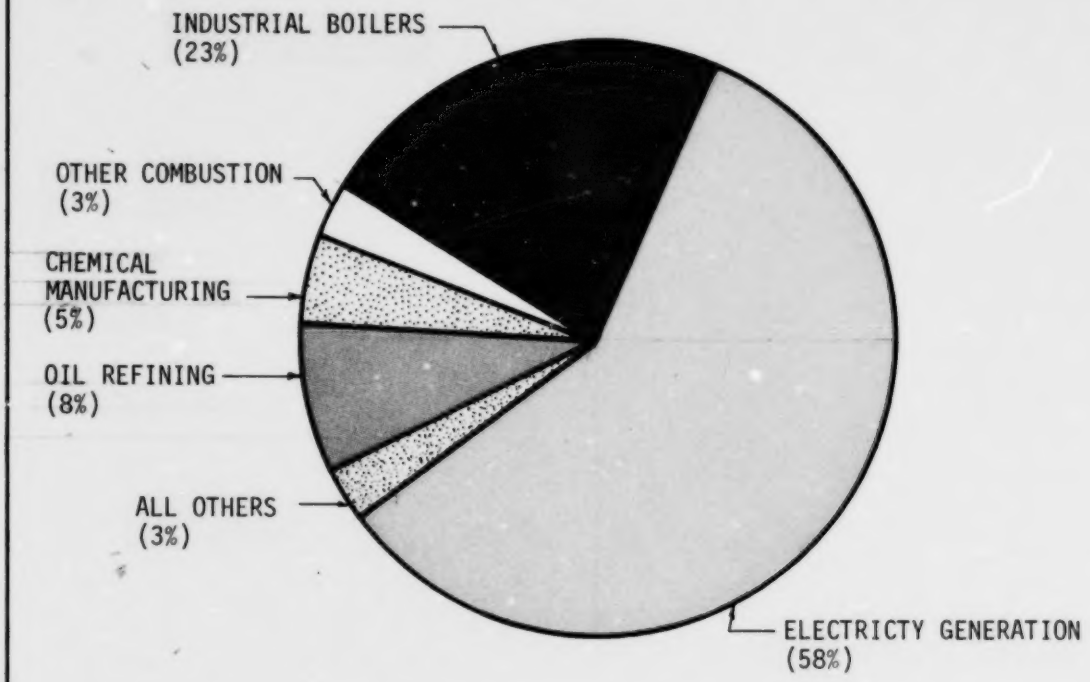
TABLE III-1

ESTIMATES OF PRESENT AND PROJECTED NO_x EMISSION LEVELS FOR POINT SOURCES IN THE PHILADELPHIA AQCR

SOURCE CATEGORY	1976 EMISSIONS (tpy) EXPECTED LEVEL	RACT	LAER	1990 EMISSIONS (tpy) EXPECTED LEVEL	RACT	LAER
Electricity Generation	89,472	44,248	25,999	93,372	48,148	29,899
Industrial Boilers	36,127	21,307	11,295	37,821	23,001	12,989
Other Combustion	4,044	2,080	1,398	4,254	2,290	1,608
Chemical Manufacturing	7,505	2,355	2,315	8,200	3,050	3,010
Oil Refining[1]	13,393	13,393	13,393	15,401	15,401	15,401
All Others	4,944	4,379	3,617	5,487	4,922	4,160
TOTALS	155,485	87,762	58,017	164,535	96,812	67,067

[1] No additional controls were assumed.

INDUSTRIAL COMPONENTS OF THE
1976 BASE YEAR POINT SOURCE
NO_x EMISSION INVENTORY FOR THE PHILADELPHIA AQCR



ELECTRICITY GENERATION	89,472
INDUSTRIAL BOILERS	36,127
OTHER COMBUSTION	4,044
CHEMICAL MANUFACTURING	7,505
OIL REFINING	13,393
ALL OTHERS	4,944
TOTAL	155,485

would be 96,812 tons per year, a 41% reduction in anticipated emissions. If LAER type controls were applied to the sources projected to be operating in 1990, NO_x emissions would be 67,067 tons per year representing a 59% reduction in anticipated point source emissions.

Stationary Area Sources

Stationary area sources include combustion from residential and commercial/institutional fuel, open burning, incineration, and structural fires. A summary of the NO_x stationary area source emission inventory (actual 1976 emissions) used in this study is presented in Table III-2. The most significant of these area source categories are those emissions resulting from residential, commercial, and institutional fossil fuel combustion. Of the total 45,616 tons per year emitted from the stationary area sources, 45,260 tons per year (99%) came from these combustion categories. Stationary area sources contributed 14% of the total NO_x emissions in the Philadelphia AQCR.

Table III-2 also illustrates the growth trends for stationary area sources in the AQCR through 1990. The activity level of these sources is expected to increase by about 13% between 1976 and 1990.

Since the potential NO_x attainment problem is only present in the City of Philadelphia with much lower ambient air NO_x concentrations in the remainder of the AQCR, the policy options were examined only for the city. Therefore, a stationary area source emissions inventory for the city was developed for the analysis. A summary of the inventory is presented in Table III-3. Again, emissions resulting from residential, commercial, and institutional fossil fuel usage account for over 99% of total stationary area source emissions in both the base year and projected 1990. Summaries of stationary area source emissions for the other counties in the AQCR are included in Appendix C.

Since RACT controls presently do not apply to area sources and LAER applies only to new or modified major point sources, RACT and LAER scenarios have not been developed for stationary area sources in either the base year or 1990.

Mobile Sources

Emissions from mobile sources include road vehicles (tailpipe emissions), rail locomotives, aircraft, ships, and other off-road vehicles. Total emissions from mobile sources were 123,879 tons per year or 38% of the total 1976

TABLE III-2

ESTIMATES OF PRESENT AND PROJECTED NO_x EMISSION LEVELS FOR STATIONARY AREA SOURCES IN THE PHILADELPHIA AQCR

SOURCE CATEGORY	EMISSIONS (tpy) 1976	1990
Residential fuel	16,905	20,000
Commercial/Institutional fuel	28,355	31,000
Open burning	125	290
Incineration	140	153
Structural fires	91	97
TOTALS	45,616	51,540

TABLE III-3

ESTIMATES OF PRESENT AND PROJECTED NO_x EMISSION LEVELS FOR STATIONARY AREA SOURCES IN THE CITY OF PHILADELPHIA

SOURCE CATEGORY	EMISSIONS (tpy) 1976	1990
Residential fuel	7,300	8,000
Commercial/Institutional fuel	11,000	12,000
Open burning	20	45
Incineration	50	54
Structural fires	30	30
TOTALS	18,400	20,129

NO_x emissions for this AQCR. In this category, road vehicle emissions were the highest generating 81% of the base year mobile source NO_x emissions.

The base year and projected 1990 NO_x emissions in the AQCR attributable to mobile sources are summarized in Table III-4. Emissions from this category are expected to decrease by about 33% from 1976 levels. This is a result of the emissions reductions due to the Federal Motor Vehicle Control Program (FMVCP) and vehicle turnover more than offsetting the emissions gains due to increased vehicle-miles-traveled (VMT).

Table III-4 also illustrates the effect of applying LAER type controls to the mobile source NO_x emissions. In this case, LAER control would mean a transporation control plan which when implemented would result in a 20% decrease in VMT. Such a plan would further reduce the base year and projected 1990 mobile source emissions inventory by 20,076 and 11,523 tons per year, respectively.

Again, the policy options were examined only for the City of Philadelphia, therefore, a mobile source emissions inventory for the city was developed for the analysis. A summary of the inventory is presented in Table III-5. A decrease in mobile source emissions, similar to the change in the AQCR is expected. Table III-5 also illustrates the effect of applying LAER type controls to the mobile source NO_x emissions. Again, LAER control implies a 20% transporation control plan. Such a plan would further reduce the base year and projected 1990 mobile source emissions inventory by 3,593 and 2,272 tons per year, respectively.

Background Emissions

A cursory analysis of the NO_x emissions which were not accounted for in any of the above major point, stationary area, or mobile source categories in the AQCR was completed. This estimate was based on a proportional relationship between emissions and air quality. The background emissions correspond to background levels in ambient air quality even though the background burden is transported into and not emitted within the AQCR. A background level of 6 ppb was assumed throughout (see Appendix C). This gave an equivalent background emission level of 64,780 tons per year or 17% of the total

TABLE III-4

ESTIMATES OF PRESENT AND PROJECTED NO_x EMISSION LEVELS

FOR MOBILE SOURCES IN THE PHILADELPHIA AQCR

	1976 EMISSIONS (tpy)			1990 EMISSIONS (tpy)		
SOURCE CATEGORY	EXPECTED LEVEL	RACT	LAER	EXPECTED LEVEL	RACT	LAER
Highway Vehicles	100,379	100,379	80,303	57,616	57,616	46,093
Farm and Construction Vehicles	8,795	8,795	8,795	8,200	8,200	8,200
Railroads, Aircraft, Vessels	14,705	14,705	14,705	17,000	17,000	17,000
TOTALS	123,879	123,879	103,803	82,816	82,816	71,293

TABLE III-5

ESTIMATES OF PRESENT AND PROJECTED NO_x EMISSION LEVELS

FOR MOBILE SOURCES IN THE CITY OF PHILADELPHIA

	1976 EMISSIONS (tpy)			1990 EMISSIONS (tpy)		
SOURCE CATEGORY	EXPECTED LEVEL	RACT	LAER	EXPECTED LEVEL	RACT	LAER
Highway Vehicles	17,965	17,965	14,372	11,362	11,362	9,090
Farm and Construction Vehicles	3,365	3,365	3,365	3,200	3,200	3,200
Railroads, Aircraft, Vessels	5,435	5,435	5,435	6,000	6,000	6,000
TOTALS	26,765	26,765	23,172	20,562	20,562	18,290

NO_x emissions for the AQCR. Use of this equivalent emission level facilitates discussion by making it possible to consider pollution levels or emission levels separately.

For Philadelphia, a brief analysis of the NO_x emissions which were not accounted for in any of the source categories inventoried was also completed. Again, the emissions estimate was based on a proportional relationship between emissions and air quality with an assumed background concentration of 6 ppb. This gave an equivalent background emission level of 9,968 tons per year or 11% of the total NO_x emissions in the City of Philadelphia.

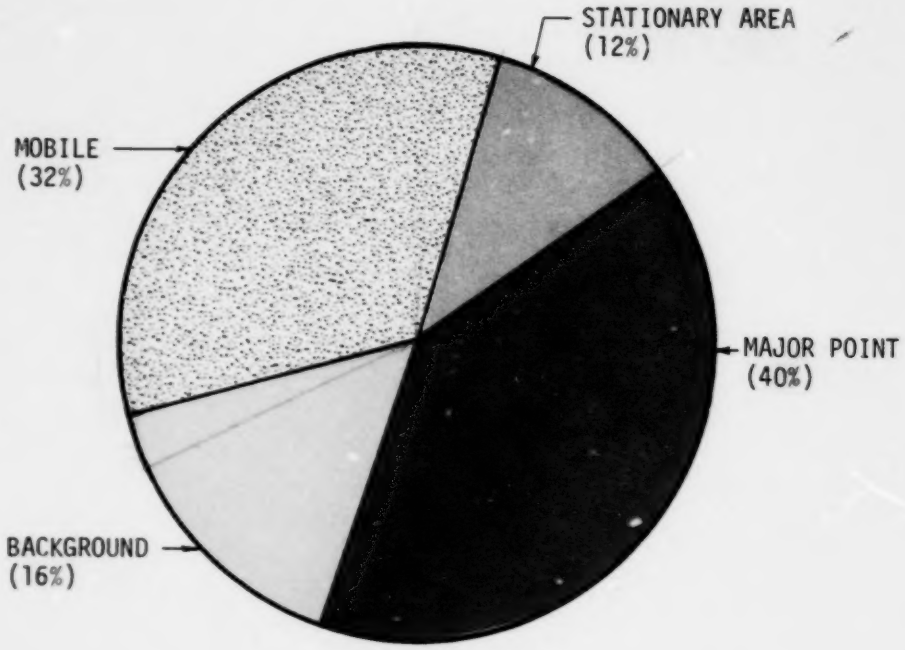
Total Emissions

The 1976 NO_x emissions listed in Tables III-1, III-2, and III-4 are summarized along with the estimated background emissions in Figure III-2. The annual base year emissions from all sources (including background) amounts to 389,760 tons per year in 1976 (Table III-6). Of this, about 32% is attributable to mobile sources and 81% of that is due to highway vehicle emissions (Table III-4). Stationary area sources comprise 12% of the emissions. Point sources contribute about 40% of the total emissions and 81% of that is due to electricity generation and industrial boilers. Clearly, the greatest opportunity to reduce emissions is found in mobile and major point sources.

The projected 1990 NO_x emissions for the Philadelphia AQCR listed in the aforementioned tables have been summarized (Figure III-3). The annual 1990 emissions from all sources (including background) amounts to 379,070 tons per year. Of this, about 22% is attributable to mobile sources and 70% of that is due to highway vehicle emissions. Stationary area sources comprise 14% of the emissions. Point sources contribute about 47% of the total emissions and 80% of that is due to electricity generation and industrial boilers.

For the City of Philadelphia, the 1976 NO_x emissions included in the inventory are summarized in Figure III-4. The annual base year emissions from all sources (including background) amounts to 93,032 tons per year in 1976 (Table III-7). Of this, about 29% is attributable to mobile sources and 67% of that is due to highway vehicle emissions (Table III-5). Stationary area sources comprise 20% of the emissions. Point sources contribute

1976 BASE YEAR NO_x EMISSION INVENTORY
FOR THE PHILADELPHIA AQCR



MAJOR POINT SOURCES	155,485
STATIONARY AREA SOURCES	45,616
MOBILE SOURCES	123,879
BACKGROUND (AIR QUALITY EQUIVALENT)	64,780
TOTAL	389,760

TABLE III-6

ESTIMATES OF PRESENT AND PROJECTED NO_x EMISSION LEVELS

FOR ALL SOURCES IN THE PHILADELPHIA AQCR

	1976 EMISSIONS (tpy)			1990 EMISSIONS (tpy)		
SOURCE CATEGORY	EXPECTED LEVEL	RACT	LAER	EXPECTED LEVEL	RACT	LAER
Major point	155,485	87,762	58,017	164,535	96,812	67,067
Stationary area	45,616	45,616	45,616	51,540	51,540	51,540
Mobile	123,897	123,879	103,803	82,816	82,816	71,293
TOTALS	324,980	257,257	207,436	298,891	231,168	189,900

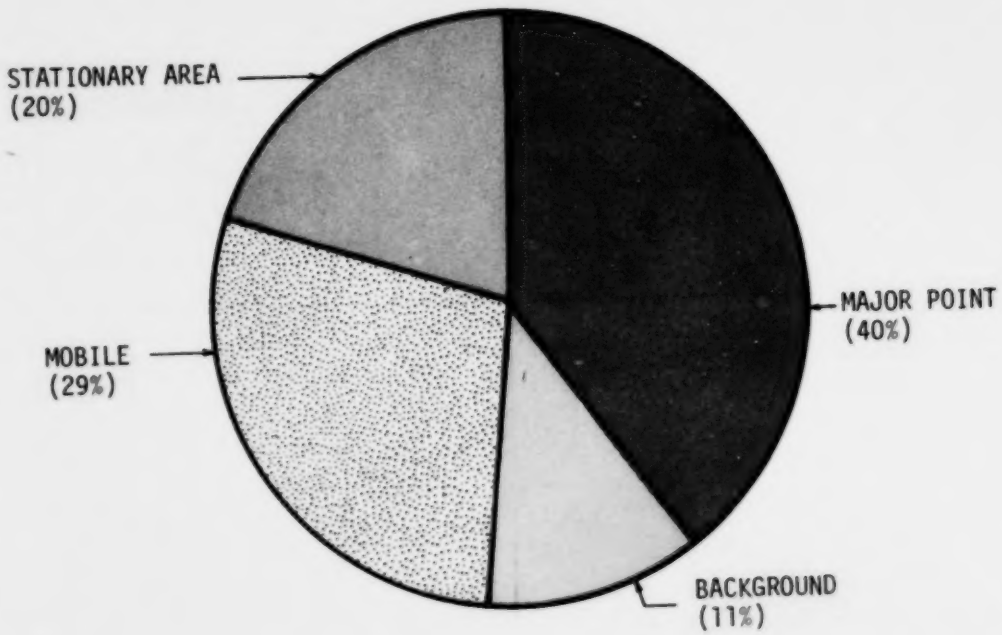
TABLE III-7

ESTIMATES OF PRESENT AND PROJECTED NO_x EMISSION LEVELS

FOR ALL SOURCES IN THE CITY OF PHILADELPHIA

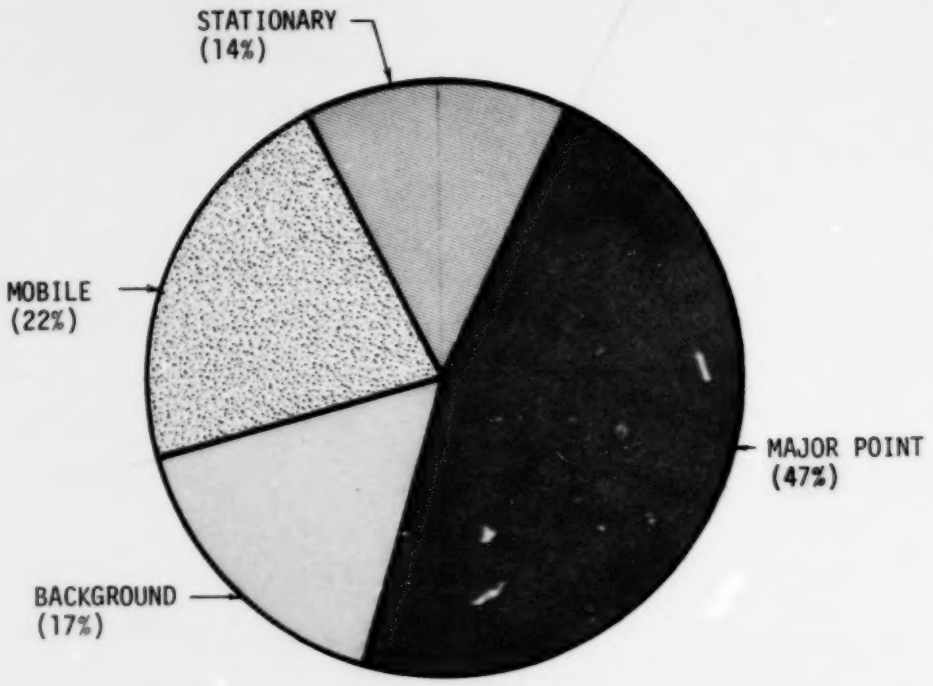
	1976 EMISSIONS (tpy)			1990 EMISSIONS (tpy)		
SOURCE CATEGORY	EXPECTED LEVEL	RACT	LAER	EXPECTED LEVEL	RACT	LAER
Major point	37,899	21,392	14,141	40,105	23,598	16,347
Stationary area	18,400	18,400	18,400	20,129	20,129	20,129
Mobile	26,765	26,765	23,172	20,562	20,562	18,290
TOTALS	83,064	66,557	55,713	80,796	64,289	54,766

1976 BASE YEAR NO_x EMISSION INVENTORY FOR
THE CITY OF PHILADELPHIA



MAJOR POINT SOURCES	37,899
STATIONARY AREA SOURCES	18,400
MOBILE SOURCES	26,765
BACKGROUND (AIR QUALITY EQUIVALENT)	9,968
TOTAL	93,032

PROJECTED 1990 NO_x EMISSION INVENTORY
FOR THE PHILADELPHIA AQCR



MAJOR POINT SOURCES	179,934
STATIONARY AREA SOURCES	51,540
MOBILE SOURCES	82,816
BACKGROUND (AIR QUALITY EQUIVALENT)	64,780
TOTAL	379,070

about 41% of the total emissions. Clearly, the greatest opportunity to reduce emissions in the city of Philadelphia is also found in mobile and major point sources.

The projected 1990 NO_x emission level for the City of Philadelphia listed in the aforementioned tables have also been summarized (Figure III-5). The annual 1990 emissions from all sources (including background) amounts to 90,764 tons per year. Of this, about 22% is attributable to mobile sources and 66% of that is due to highway vehicle emissions. Stationary area sources comprise 21% of the emissions and major point sources contribute about 46% of the total emissions.

SIP ALLOWABLE EMISSIONS

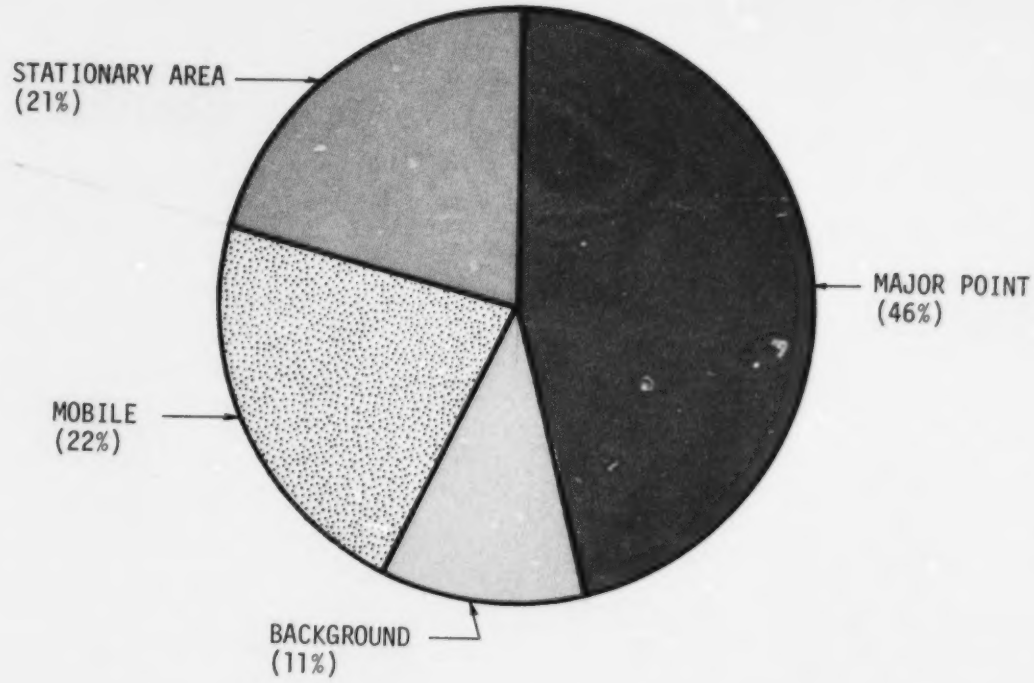
SIP allowable emission levels refer to the maximum permissible emissions for a given source or process category. The limits are usually specified in terms of pounds of emissions allowed for some level of production. For example, sulfur dioxide emissions are limited to 0.6 pounds per 10^6 BTU heat input. For particulates and sulfur dioxide, regulatory agencies have to this time specified maximum persmissible emission levels. However, a SIP allowable emission level for NO_x sources does not apply in this case because the Philadelphia AQCR has been attaining the NO_x NAAQS and an NO_x SIP, therefore, has not been developed.

For the purpose of this study, it was assumed that SIP allowable emission levels were identical to the actual base year emissions. The primary thrust of this study was to examine the potential for reducing, if necessary, actual emissions through the adoption of various policy options.

CONTROL TECHNOLOGY DEFINITIONS

Definitions of RACT and LAER are specified in Appendix D for a number of industrial point source processes. These definitions were applied to each stack/source in the inventory and then summed to determine emissions over the entire AQCR. If an emission source already had controls which were better than the RACT/LAER assumptions used in this analysis, no change in RACT/LAER emissions was calculated. Thus, for this analysis, application of RACT or LAER controls to major point sources could only reduce emissions.

PROJECTED 1990 NO_x EMISSION INVENTORY FOR
THE CITY OF PHILADELPHIA



MAJOR POINT SOURCES	40,105
STATIONARY AREA SOURCES	20,129
MOBILE SOURCES	20,562
BACKGROUND (AIR QUALITY EQUIVALENT)	9,968
TOTAL	90,764

For stationary area sources of NO_x, controls through RACT and LAER cannot be specified because such controls on these traditionally uncontrolled sources are not presently being considered. However, for mobile sources, control through LAER was defined as a 20% transportation control plan (increasing the stringency limits of an inspection/maintenance program would not effect NO_x emissions).

GROWTH IN EMISSIONS AND REPLACEMENT RATES

Major Point Source Construction

Table III-1 and Appendix C show the increases in major point source NO_x emissions expected between 1976 and 1990 for the Philadelphia AQCR and the City of Philadelphia, respectively. By 1990, emissions are expected to increase in the AQCR by 9,050 tons per year or 6% of the base year 1976 emission levels and in the city by 5,685 tons per year or 15% of the base year emissions. Growth estimates were obtained from a number of different sources including: local state planning agencies, other EPA contractors, and recently published articles in technical journals. By knowing the production rates for the base year and the anticipated growth, production in any future period could be predicted. Emission increases would, of course, correspond to increases in production. In this analysis, all new major source growth was assumed to use LAER controls. This is consistent with the present policies in the AQCR which requires best available control technology (RACT) on new sources. Additional information on growth for major point sources by individual SIC categories can be found in Appendix B.

By 1982, point source emissions for the AQCR and the city are expected to increase by 3,879 and 945 tons per year of NO_x, respectively. This represents a 2.5% increase over the base year emission levels. Thus, if nonattainment is established in the AQCR or the City, this growth will have to be accommodated by additional emission source reductions prior to 1982 for the Commonwealth of Pennsylvania to show attainment of the NO_x air quality standard.

Mobile and Stationary Area Sources

Tables III-6 and III-7 summarize the decreases in mobile source emissions and the increases in stationary area source emissions between the base year

and 1990 for the AQCR and the City of Philadelphia, respectively. Although there was an increase in the vehicle miles traveled in both cases, mobile source emissions were expected to decrease substantially between 1976 and 1990 because of the Federal Motor Vehicle Control Program (FMVCP). The reduction in emissions which resulted from the FMVCP was far greater than the potential increase due to increased travel.

Mobile sources were projected by using DVRPC projections of vehicle miles traveled and the same (base year) travel characteristics: speed, temperature, hot/ cold start percentages, etc. New emission factors had to be calculated because of the ongoing Federal Motor Vehicle Control Program. These calculations were made for the critical years 1976, 1980, and 1990 and linearly extrapolated to other study years.

The aforementioned tables also summarize the expected increases in stationary area source NO_x emissions due to population increases in the AQCR and the City. By 1990, stationary area source emissions are expected to increase in the AQCR by 5,924 tons per year or 13% of the base year 1976 emission levels and in the City by 1,729 tons per year or 9% of the base year emissions. Growth estimates for stationary area sources were obtained primarily from local and state planning agencies.

By 1982, area source emissions (including both stationary area and mobile sources) are expected to decrease by 15,059 and 1,917 tons per year for the AQCR and the City, respectively. In both cases, the emissions reductions will more than offset the emissions increases attributable to new point source growth. However, these emissions reductions are not sufficient to attain the NO_x air quality standard by December 31, 1982 using a proportional modeling technique.

Replacement Rate

It was assumed that industrial equipment would be replaced over time because of normal wear and fatigue. The estimates of turnover time for equipment are presented in Appendix B. The importance of replacement rate to this study derives from the fact that new equipment and facilities with LAER (proposed NSPS) control technology will replace existing high emitters.

Replacement rates were calculated using the EPA AQMA guideline procedure which suggests that the useful life be set at twice the IRS depreciation period.

For example, assuming LAER replacements started in 1977, 14/22 or 63.6% of the chemical industry emissions will have converted to LAER by 1990 and the emissions would have been reduced from 7,015 tons per year to 6,275 tons per year as a result. The other industries were handled similarly. However, because these replacement rates were at best a guess of what the turnover period would be, the analyses were made first assuming no turnover and then, secondly, assuming the rates in Appendix B.

CHAPTER IV

DEMONSTRATION OF ATTAINMENT AND REASONABLE FURTHER PROGRESS REQUIREMENTS

The Clean Air Act, as amended 1977, requires that states demonstrate attainment of the primary ambient air quality standard by December 31, 1982. In making this demonstration for attainment, EPA requires that the states perform suitable dispersion modeling in each of the nonattainment areas using approved mathematical modeling techniques. Under EPA guidance to the states, the SIP must also contain procedures for attaining the secondary ambient air quality standards. However, since the primary and secondary ambient air quality standards for NO_x are the same, a SIP for attaining the secondary NAAQS will never be necessary.

As previously mentioned, recent ambient air NO_x data indicate a potential NO_x nonattainment problem in the City of Philadelphia. In 1977, the maximum annual arithmetic mean in the Philadelphia AQCR was .047 ppm, below the NAAQS. Based on this information and the two years of NO_x data prior to 1977, the Philadelphia AQCR was designated as unclassifiable or attainment for the air quality standard. However, the maximum annual arithmetic mean NO_x concentration recorded in the Philadelphia AQCR in 1978 was .056 ppm, above the NAAQS, with a second maximum of .054 ppm, also above the NAAQS (see Appendix A for more detail). These concentrations were recorded in the City of Philadelphia at monitoring locations identified as South and North Broad Street, respectively. Therefore, for the purpose of this study, an analysis was completed to examine policy options which might be considered should the City or AQCR be redesignated nonattainment for NO_x.

Recently, the Philadelphia Air Management Services reviewed the location of each of the monitors in the City of Philadelphia to determine compliance with the EPA Standing Air Monitoring Work Group (SAMWG) Guidelines. As a result, it was determined that the NO_x ambient air monitoring sites appear to meet the SAMWG criteria. Therfore, the 1978 NO_x data were assumed to be indicative of actual NO_x levels in the area.

DEMONSTRATION OF ATTAINMENT

The guidance from EPA on developing strategies to attain air quality standards is directed towards two concepts. One of reducing emissions and a second of improving air quality levels. Depending on the source-receptor relationship, there may be very little correlation between emissions and ambient air quality levels. The concept of attainment must, therefore, be directed towards examining those strategies which would improve air quality levels and at the same time represent a cost effective measure to reduce emissions at a few or many existing sources.

There are two central issues which are of paramount importance in analyzing strategies to attain NO_x air quality standards. A state implementation plan must contain:

- a demonstration that the .05 ppm standard will be met by December 31, 1982, and
- that reasonable further progress toward attainment of the standard will be achieved during the interim period 1979 through 1982.

Each of these two concepts will be analyzed below. There are several requirements which govern the kinds of regulations and the types of strategies that could be developed for this area in order to achieve these two goals.

A proportional modeling technique was used to estimate the 1982 and other study year ambient air NO_x concentrations in Philadelphia. This technique is not as sophisticated as the modeling techniques used to analyze the other pollutants examined in this series of studies. But, since a specific nonattainment problem has not been identified and a SIP revision to address NO_x has not been required, proportional modeling provides the basis for a cursory analysis of the policy options.

PREDICTED 1976 NO_x LEVELS WITH STRINGENT CONTROLS APPLIED

The purpose of this scenario is to show whether or not air quality levels can be achieved in the Philadelphia area. Under this assumption, it was assumed that all base year point and mobile source emissions were controlled to the maximum possible levels. This included LAER technology being

applied to point sources and a 20 percent transportation control plan for mobile sources. As a result of this effort, emissions were reduced substantially in the City of Philadelphia. Emissions changed from a total of about 83,000 tons per year to about 53,000 tons per year. Using a proportional model, the maximum predicted air quality value under this scenario was about .038 ppm.

PREDICTED 1976 NO_x LEVELS WITH RACT CONTROLS ON POINT SOURCES

This scenario would seem to be the most reasonable in estimating the kinds of emission reductions that could be expected in the City of Philadelphia. Recent SIP submittals to EPA have not contained RACT type controls for NO_x point sources because NO_x levels have been attaining the NAAQS and NO_x SIP development has not been necessary. Furthermore, New Source Performance Standards (NSPS) have not been established for major new or modified point sources, stationary area sources have not been traditionally controlled, and NO_x emission reductions from mobile sources have only been realized through vehicle turnover and the associated Federal Motor Vehicle Control Program (FMVCP). In summary, emissions of NO_x have essentially been uncontrolled, except for the FMVCP, to this point in time. However, if a nonattainment problem is established in Philadelphia, controls over-and-above the FMVCP will be necessary

Under this scenario, it was assumed that all point sources were controlled to the RACT level. As a result of this effort, emissions were changed significantly. Base year emissions from point sources in Philadelphia changed from a total of about 38,000 tons per year to about 21,000 tons per year. The maximumm air quality levels under this scenario was estimated to be about .046 ppm at the highest monitoring site. This estimated concentration level is below the NAAQS of .05 ppm, annual arithmetic mean. Of course, this is a hypothetical case indicating what levels could have been reached in the base year with RACT type controls applied to existing point sources. When possible growth in emissions is considered, concentrations may exceed the .05 ppm standard in 1982.

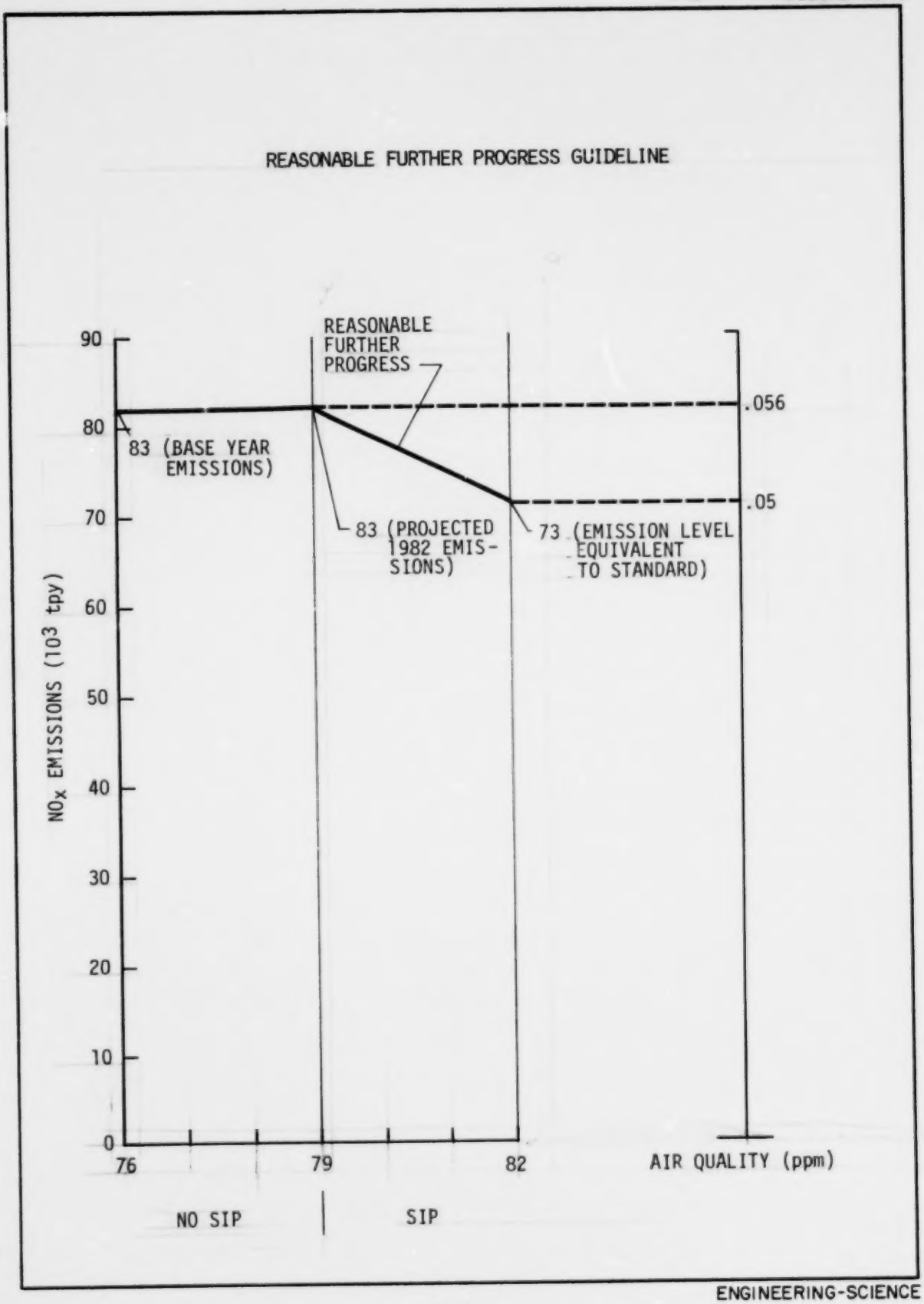
ATTAINMENT OF THE STANDARD

Vehicle turnover and the associated FMVCP will result in reductions of NO_x emissions from the mobile source sector in future years. These decreases are projected to be sufficient to offset the increases anticipated from major point and stationary area sources. Annual mobile source NO_x emissions will decrease by 2,658 tons per year in Philadelphia between 1976 and 1982 while the emissions contribution from major point (assuming LAER on new sources) and stationary area sources will increase by only 1,686 tons per year. However, if a nonattainment problem is established in the City of Philadelphia, this net reduction will not be sufficient to attain the NO_x NAAQS. Additional reductions will be required to attain the standard by December 31, 1982. These reductions could come from implementing RACT type controls on major point sources as was done above for the base year case. Such reductions are projected to be more than adequate to reduce ambient air NO_x concentrations to acceptable levels, even with growth considered.

REASONABLE FURTHER PROGRESS REQUIREMENTS

During the interim period 1979 to 1982, progress must be made toward attaining the primary ambient air quality standards. In the guidance issued from EPA to the states developing plans for attainment, states are required to establish programs that would continuously reduce emissions during this period. The reasonable further progress guideline is defined by EPA as being a line which connects the emission level in 1979 with that level required to just attain standards in 1982. Based on the assumption of proportionality between NO_x emissions and NO_x ambient air levels, a determination of the 1982 emissions level at which the standard will be attained in Philadelphia has been completed. Figure IV-1 illustrates the reasonable further progress line. The NAAQS for NO_x corresponds to an emissions level of 73,096 tons per year. A net reduction in NO_x emissions of 8,996 tons per year between 1979 and 1982 may be required for attainment in 1982.

FIGURE IV-1



ENGINEERING-SCIENCE

CHAPTER V

GROWTH AND POTENTIAL FOR ATTAINING AND MAINTAINING STANDARDS

In this chapter, emissions changes that can be expected from the implementation of each of the policy options are analyzed. Base year emissions in all source categories were augmented or reduced according to growth and control technology changes dictated by each future scenario. The analysis focuses on the period 1976 through 1982, the attainment date specified by the Clean Air Act Amendments of 1977. In addition to addressing whether or not the NO_x standard could be attined by 1982, an analysis was also performed to determine whether the reasonable further progress requirements could be achieved during the interim period, 1979 through 1982. A brief discussion of maintenance of the ambient air quality standard for NO_x through 1990 is also included.

BASE CASE: PRE-1979 SIP WITH MAJOR SOURCE CONSTRUCTION

An analysis was made of emission levels assuming that the current SIP (no regulations) would remain in effect through the year 1990. It was further assumed that permitting procedures, which would require the use of LAER (proposed NSPS) control technology on all new expansions in this area, would be in effect over this period. Under this scenario, no emission reductions were required for existing major sources. Area sources were assumed to grow but have no more control than in the base year 1976.

This particular scenario was not a policy option that was being considered by EPA, but rather reflects the changing emissions and resultant air quality if there were no SIP revisions. It is not necessarily a worse case scenario since new point sources will have LAER type controls.

Table V-1 presents the change in emissions in the City of Philadelphia from 1976 through 1982 under this base case scenario. The air quality impacts of these emissions at the maximum receptor site are also identified. Emissions of NO_x will decrease from a level of 83,064 tons per year in base year 1976 to 82,042 tons per year by 1982 under what has been defined to be Pre-1979 SIP.

TABLE V-1

EXPECTED CHANGE IN AIR QUALITY
BETWEEN 1976 AND 1982
UNDER VARIOUS CONTROL SCHEMES

CONTROL SCHEME	EMISSIONS DECREASE (TPY)	AIR QUALITY DECREASE (PPM)
Pre-1979 SIP with Growth[1]	972[2]	.001
RACT SIP with Growth	17,479[2]	.010
RACT SIP with Offsets		
1:1 Offsets	17,479[2]	.010
3:1 Offsets	17,479[2]	.010
RACT SIP with No Major Construction	17,952	.011
LAER Replacement with No[3] Major Construction	28,230	.017

1 Assumes no existing SIP.

2 Assumes LAER control technology on new major source growth.

3 Maximum possible control scenario.

The emission change is not that substantial because of the reductions attributable to the ongoing FMVCP tending to offset increases in the major point and stationary area source categories. As a result of the change in emissions from 1976 to 1982, air quality levels should also change. Based on the assumed proportionality of emissions and air quality, the decrease in air quality will be about 1 ppb, annual arithmetic mean.

POLICY OPTION: RACT SIP WITH MAJOR SOURCE CONSTRUCTION

An analysis was made of the NO_x emissions assuming that all existing sources were controlled to the RACT level by 1982. It was further assumed that all new source growth met LAER control technology requirements and that area sources were allowed to grow with no control. Table V-1 shows the change in emissions and the subsequent air quality impact at the maximum receptor site in the City between 1976 and 1982 under this particular scenario.

Emissions of NO_x will decrease from a level of 83,064 tons per year in 1976 to 65,585 tons per year by 1982 under this scenario. These reductions would correspond to a decrease of approximately 10 ppb in ambient air NO_x concentrations. Therefore, it would be possible to attain the NAAQS for NO_x by just applying RACT controls to existing major point sources.

Reasonable further progress criteria have been discussed in Chapter IV. Figure V-1 illustrates the change in emissions through time between 1976 and 1982 for this scenario. Controls at the RACT level on existing point sources provide sufficient reductions to meet the reasonable further progress guideline. In fact, approximately 7,000 tons per year of additional NO_x growth could be accommodated under this scenario.

POLICY OPTION: RACT SIP WITH OFFSETS FOR NEW MAJOR SOURCE CONSTRUCTION

In nonattainment areas, new source growth after 1979 can be accommodated by an emission offset program or allowances can be made for such growth in the SIP revision. Many states will be incorporating the emission offset policy into their existing permitting system when they revise their SIPs and submit these to EPA in early 1979. Other states will likely develop

an "accommodative SIP." Under this program, agencies will estimate the increases expected from new major source construction and plan to control existing sources such that the new emissions can be easily accommodated without having to offset emissions. Under this particular scenario analyzed, the emission offset policy is assumed to be in effect from the end of 1979 through 1990. Various offset ratios will be examined to illustrate the impact higher offset ratios would have on overall attainment of NO_x standards in this area.

The base scenario analyzed under this policy option would require that new emissions be offset by a ratio of exactly 1:1. A higher offset ratio was also examined. In the second case, emissions were asumed to be offset at a ratio of 3:1.

Under the present EPA guidance, emission offsets are required for any new sources locating in a designated nonattainment area. For the purpose of this analysis, we have assumed that the designated nonattainment area is the City of Philadelphia. Thus, sources which will be locating in other portions of the AQCR would not be required to obtain emission offsets. If all new major sources located in these areas, this policy option would be identical to the one described previously, the RACT SIP with major source construction. The present guidance from EPA also requires that any source that will locate near a nonattainment area which has a "significant impact" on the nonattainment area must also offset new emissions. This kind of engineering analysis is extremely difficult to complete and depends entirely on the AQDM in order to determine which new sources will have a significant impact on ambient air quality in the designated nonattainment areas. Therefore, these sources with significant impacts were not included in the analysis.

Of the approximately 3,900 tons per year of new LAER NO_x emissions anticipated between 1976 and 1982 for the AQCR, about 950 tons per year were assumed to occur in the City of Philadelphia. The emission offset analysis described in this section of the report assumes that only this level of emissions will be offset from existing sources in that area.

There were about 15,600 tons per year of offsets available in the City of Philadelphia. These were offsets which could be obtained by retrofitting

existing point sources with just RACT controls. If LAER controls could be retrofitted on point sources, an additional 7,200 tons per year of offsets could be obtained. Thus, the total available offsets for the City was 22,800 tons per year. In these computations, the existing sources were assumed to comply with RACT type regulations in 1982. In summary, there were an abundance of offsets available to accommodate new source growth in Philadelphia.

1:1 Emission Offsets

About 950 tons per year of new major source emissions are expected in the City of Philadelphia between 1976 and 1982. There are presently many available offsets from point sources in the county. If necessary, additional offsets may be found from mobile sources by assuming a transportation control plan which would reduce vehicle-miles-traveled. No analysis was completed to show how the aforementioned reduction in emissions would occur. There seemed to be a sufficient number of offsets available for any new sources locating in this area. Specifically, approximately 470 tons per year of new LAER emissions will need to be offset by 1982; however, the emission reductions from vehicle turnover and the associated FMVCP will be more than sufficient to counter these increases. If the offsets available from applying RACT controls to existing major point sources were to be used, sufficient reductions would also be available. In effect, this scenario does not differ from the RACT SIP with major source construction policy options.

Assuming all new point source growth is major source, emissions decrease from a level of 83,064 tons per year in 1979 to 65,585 tons per year by 1982 under this scenario. These reductions would correspond to a decrease of approximately 10 ppb in ambient air NO_x concentrations. Therefore, it would be possible to attain the NAAQS by applying RACT controls to existing major point sources and requiring offsets for post-1979 LAER emissions. The reasonable further progress criteria would also be met under this scenario (see Figure V-1).

3:1 Emission Offsets

Under this particular scenario, we will examine the impact on air quality by adding an additional 470 tons per year of NO_x emissions in the City of Philadelphia, but requiring an offset ratio of 3:1. These new LAER emissions will need to be offset by 1982; however, the emission reductions from vehicle

turnover and the associated FMVCP will, at the ratio of 3:1, just equal the LAER emission growth between 1979 and 1982. If the offsets available from applying RACT controls to existing point sources were to be used, sufficient reductions would also be available. In effect, this scenario does not differ from either the RACT SIP with major source construction or the RACT SIP with 1:1 offsets for new major source construction policy options.

POLICY OPTION: RACT SIP WITH NO MAJOR CONSTRUCTION AFTER 1979

Under this policy option, it was assumed that all NO_x emissions were controlled to the RACT level. Furthermore, after year end 1979 no new major source growth would be allowed in the City of Philadelphia. Under this policy option, substantial emission reductions will occur between 1979 and 1982 as a result of implementing further controls to existing point source emissions. As a result, some decrease in ambient air quality is expected by 1982 when all of the RACT regulations were assumed to be in effect.

Table V-1 presents the change in emissions and ambient air quality between 1976 and 1982 for this particular scenario. Emissions of NO_x will decrease from a level of 83,064 tons per year in 1976 to 65,112 tons per year in 1982. These reductions will correspond to a decrease of approximately 11 ppb in ambient air NO_x concentrations. Therefore, it would be possible to attain the NAAQS for NO_x under this policy option. Furthermore, the reasonable further progress criteria as depicted in Figure V-1 would also be met under this scenario.

POLICY OPTION: LAER REPLACEMENT WITH NO MAJOR SOURCE CONSTRUCTION AFTER 1979

This policy option assumed LAER control technology on both new and existing major point sources in the City of Philadelphia. In this scenario, it was assumed that, in addition to new sources, existing sources being replaced would use a LAER control technology. This was assumed to take place completely and uniformly over the interval from 1979 to 1990. Stationary area source growth was projected to continue. The mobile sources on the other hand, were restricted by a 20 percent transportation control plan imposed in 1982. This program reduced vehicle miles traveled and hence NO_x emissions by 20 percent.

Regarding the replacement rates of existing sources, Appendix B describes the retirement and replacement schedules for major industries that are located in the study area. This data was largely extracted from IRS depreciation da a. The EPA procedure is to multiply the depreciation estimates by two and assume that this represents the useful life of the specific equipment. This methodology may underestimate the useful life of sources in the AQCR. However, the procedure has been used to tabulate the turnover rate of old industry being replaced with new control facilities.

Emissions of NO_x will also decrease under this scenario from a level of 83,064 tons per year in 1976 to 54,834 tons per year by 1982. These reductions will correspond to a decrease of approximately 17 ppb in ambient air NO_x levels as indicated in Table V-1. Therefore, it would be possible to attain the NO_x standard by applying this scenario to sources in the City of Philadelphia.

Figure V-1 illustrates the time series of emissions trends from 1976 through 1990. Also illustrated in the figure is the reasonable further progress guideline. This scenario provides more than enough emission reduction to meet these criteria. In fact, more additional growth can be accommodated than under the RACT SIP policy option.

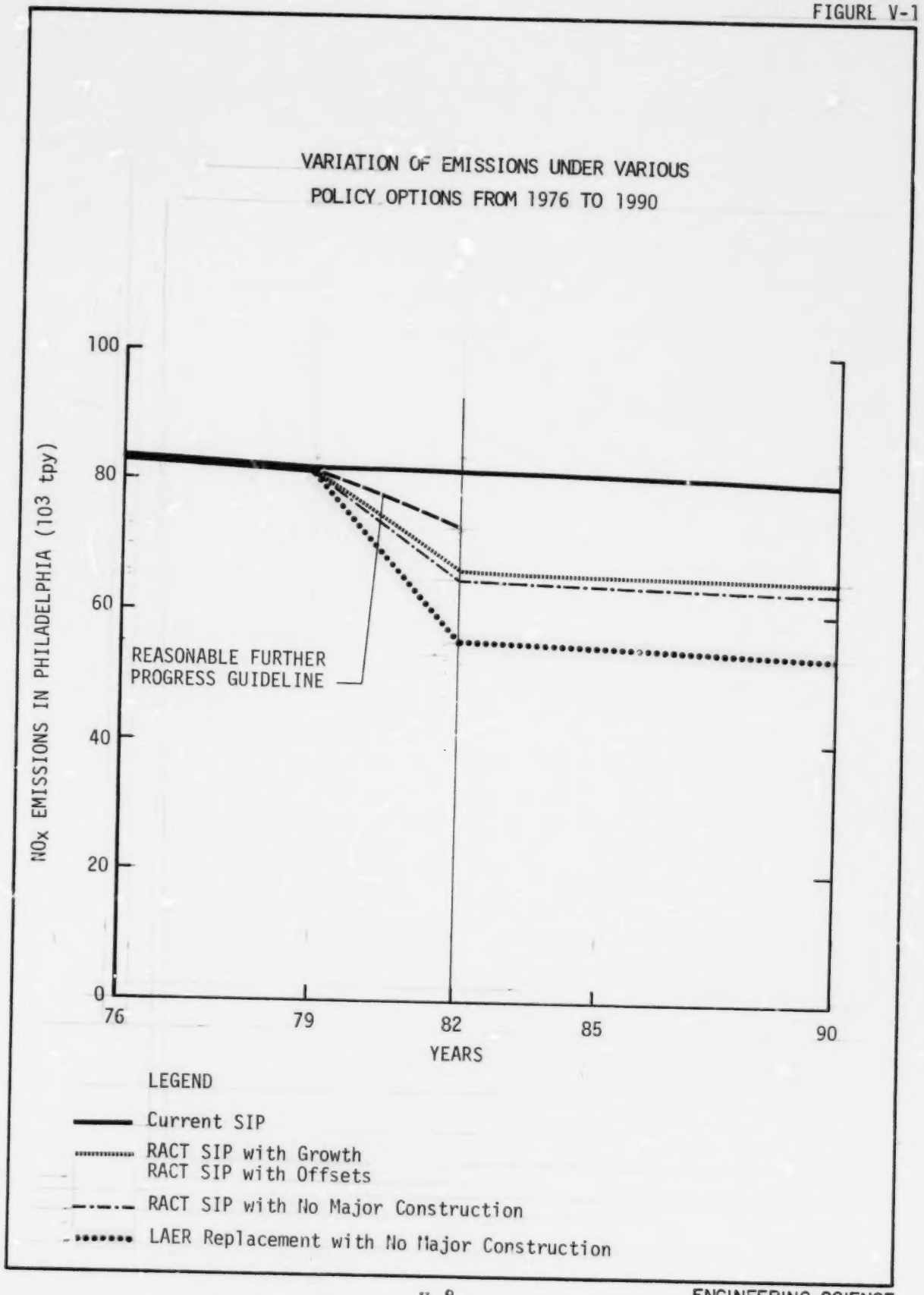
ANALYSIS OF POLICY OPTIONS STUDIED

The policy options investigated in this study centered around various emission reductions programs. Although it is important that emissions be reduced substantially, the primary concern is the improvement in ambient air quality levels. If some form of control is not instituted, ambient air NO_x levels are projected to neither increase nor decrease significantly by 1982. All policy options examined provided sufficient air quality improvement to attain the NO_x air quality standard by the end of 1982.

MAINTENANCE OF THE NAAQS

In addition to attainment of NAAQS's by December 31, 1982, the EPA requires that once attainment is reached, the NAAQS must be maintained. This section discusses the ambient air quality levels resulting from 1990 NO_x emissions under the various policy options this study addresses.

FIGURE V-1


VARIATION OF EMISSIONS UNDER VARIOUS
POLICY OPTIONS FROM 1976 TO 1990
NOx EMISSIONS IN PHILADELPHIA (103 tpy)
100
80
60
40
20
0
76
79
82
85
90
YEARS
REASONABLE FURTHER
PROGRESS GUIDELINE
LEGEND
Current SIP
RACT SIP with Growth
RACT SIP with Offsets
RACT SIP with No Major Construction
LAER Replacement with No Major Construction

Projected 1990 NO_x emissions for all of the policy options examined have been presented in Table III-7. If a proportional relationship of emissions and air quality is assumed, the 1990 air quality in the City of Philadelphia under the various scenarios is as follows:

Policy Option	NO_x Concentration (ppm)
Current SIP	.056
RACT SIP with Growth	.045
RACT SIP with Offsets	
1:1 Offsts	.045
3:1 Offsets	.045
RACT SIP with No Major Construction	.044
LAER Replacement with No Major Construction	.038

When these air quality data are compared to the estimated 1982 air quality, it is apparent that degradation of air quality between 1982 and 1990 is nonexistent. With assumed growth under the RACT and LAER SIP options, air quality even improves. As previously mentioned, this is attributable to the FMVCP offsetting emission increases from stationary sources. The potential NO_x problem in the City of Philadelphia is not one of NAAQS maintenance, but, one of establishing an initial decrease in NO_x emissions to attain the NAAQS in 1982.

SENSITIVITY ANALYSES

In conducting these analyses, numerous assumptions had to be made which could effect the outcome of the conclusions for this particular study. Several of the major input variables will be analyzed below in order to determine how significant the assumptions were in evaluating the policy options.

Emission Inventory Data

The dominant components of the emission inventory were the major point and mobile sources. However, these may be the least reliable of all of the source estimates. For point sources, the emission inventory may not have been comprehensive in coverage or may have been inaccurate in critical process parameters. Mobile source emissions may not be reliable because of the many parameters for which regional specific data were not available (e.g., vehicle mix by road class) and because of the broad categorization (e.g., only two road classifications) that was necessary. However, the effect of being in error by 20 percent in the mobile source component was tested.

An overestimate of 20,000 tons per year would mean that total emissions were about 63,000 tons per year instead of the approximately 83,000 tons per year. If this were the case, the emission reduction required to attain by 1982 using rollback would have been 7,560 tons per year rather than 10,000 tons per year.

An underestimate of 20,000 tons per year would mean that total emissions were about 103,000 tons per year instead of the approximately 83,000 tons per year. If this were the case, the emission reduction required to attain by 1982 using rollback would have been 12,360 tons per year rather than 10,000 tons per year.

However, neither an overestimate or underestimate of the mobile source emissions in the base year vary the basic outcome reported previously for the RACT SIP option.

NO_x Background Value

Perhaps the most critical parameter used in this study, since it uniquely determines the reduction in emissions required to attain the standard, is the NO_x background level. If a background value of 20 ppb were used in the analysis rather than the assumed 6 ppb, the percentage reduction required for attainment would increase from 12 to 17. This additional reduction would translate into 4,000 tons per year. But, the growth accommodation identified earlier for the RACT SIP policy option could account for this additional reduction. Therefore, the basic outcome previously reported would not vary.

Growth Rate

The range of estimates on expected growth by industrial category is given in Appendix B. An intermediate was selected in every category for the study presented herein. These growth rates represented government projections, such as OBERS, and the opinions of local industrialists. The extreme high and low values of the growth rates were given a cursory review to test the sensitivity of the results of this study to growth. Neither a optimistic nor a pessimistic outlook on future growth provided sufficient NO_x emission increases which would consume the growth accommodation provided by the policy options.

Control Technology

Definitions were made for RACT and LAER controls for the purpose of this study. They are presented in Appendix D along with the underlying rationale. They were held fixed, however, for the entire 14-year study period, and this is most unlikely. Improvements in control technology since 1970 have been impressive. Continued improvement at a slower rate seems likely. However, since only a small decrease in NO_x emissions is required for attainment, such control technology improvement may speed attainment of the standard, but not necessarily facilitate it.

Modeling Deficiencies

Linear rollback is based on the simple but appealing assumption that the concentration of NO_x achieved is directly proportional to the amount of NO_x emitted. However, when addressing the maximum receptor site, such a simplistic approach may not be as valid for determining necessary reductions as full-scale dispersion modeling. A source-receptor relationship cannot be determined using the linear rollback technique. Such a limitation could be critical in the City of Philadelphia.

Using the proportional model, it was assumed that the mobile source emissions, which total 26,765 tons per year or 32 percent of all emissions, would be responsible for 32 percent or 16 ppb of the ambient NO_x level. However, should the mobile source contribution be greater than 16 ppb, it is possible that additional reductions in NO_x emissions will not be necessary. This is due to the fact that emissions reductions from the mobile source sector will be realized in future years. If the air quality decreases from these reductions are more than the additional air quality impacts due to growth in other source categories, attainment may be possible without controls.

APPENDIX A

AMBIENT AIR NO_x MONITORING IN THE PHILADELPHIA AQCR

Several agencies are responsible for monitoring air qualty in the different jurisdictions of the Metropolitan Philadelphia Interstate AQCR. Eleven counties in three states are involved. Data for New Castle County were provided by the Delaware Department of Natural Resources and Environmental Control; data for Mercer, Burlington, Camden, Gloucester, and Salem Counties were provided by the New Jersey Department of Environmental Protection; data for Philadelphia County were provided by the Air Management Service, Philadelphia Department of Public Health; and data for Bucks, Montgomery, Chester, and Delaware Counties were provided by the Commonwealth of Pennsylvania Air Monitoring Service (COPAMS), Pennsylvania Department of Environmental Resources. These agencies use EPA-approved monitoring techniques and provide data to the National Air Data Bank.

The NO_x monitoring sites maintained by these agencies have been shown in Figure I-2 and Table A-1 presents a summary of the NO_x observations made at these locations during calendar years 1976, 1977, and 1978. These data indicate NO_x concentrations well below the air quality standards at all monitoring sites except those located in Philadelphia. Ambient NO_x data for 1978 indicate 2 monitors recording levels near the standard in the City and 2 monitors reporting concentrations over the standard. The two monitors which indicate potential nonattainment of the NO_x standard are located along Broad Street at the northern and southern ends.

DESIGN AND BACKGROUND VALUES

Design and background NO_x levels were necessary for the proportional modeling which was used to determine necessary reductions and demonstrate attainment. Since the study conducted examined policy options which may need to be considered if a problem is identified and since the potential problem first appears in 1978, it was assumed that the maximum monitored concentration in 1978 of .056 ppm was the design value.

TABLE A-1

ANNUAL ARITHMETIC MEAN AMBIENT AIR NO_x DATA FOR THE PHILADELPHIA AQCR (1976-1978)

LOCATION	NO_x CONCENTRATION (PPM)		
	1976	1977	1978
Pennsylvania			
Bristol	.014	.016	--
Chester	.020	.023	--
Norristown	.028	.027	--
Philadelphia			
Broad and Butler Sts.	--	--	.054
20th and Parkway	.035	.032	.042
1501 E. Lycoming St.	.043	.040	.042
Broad and Spruce Sts.	.037	.047	.056
Front and Packer Sts.	.039	.039	--
Delaware			
Claymont	.027	.017	.035
New Jersey			
Camden	--	.029	.032[1]

1 Annual arithmetic mean to April 1978.

The monitoring data from sites located in nonmetropolitan areas of the AQCR were reviewed to establish a background NO_x concentration. However, it was felt that these levels were unduly influenced by local NO_x sources. Therefore, a literature search was conducted to establish a background value. Volume I of Stern's Air Pollution suggests a background NO_x concentration of 6 ppb for rural areas. This value was assumed to be indicative of background in the Philadelphia AQCR and was used in the analyses.

APPENDIX B

GROWTH PROJECTIONS

METHODOLOGY

Ideally the growth and decline of individual processes should be projected for individual plants and summed over the entire AQCR. Even the schedule of these events might be significant and also new construction or retirement of facilities (the extreme form of these events). In addition, stationary area sources should be identified where possible and the growing and declining portions should be specified. Projected highway emissions should be related to specific links by land-use and population projections. When a strong source/receptor relationhip exists, as in the case of particulates, there is almost no other way to proceed. However, the model used in the analysis could not provide an explicit source/receptor relationship; hence, an alternative projection technique was used. In general, the basic geographic unit considered for projection was the county and the net process growth, rather than the individual plant increases and decreases, was estimated directly.

Point Sources

Point sources were divided into major and minor sources according to whether or not their potential NO_x emissions exceeded 100 tons/year.

Major Sources

The LAER emissions for each process in each plant calculated for the base year by the methods outlined in Appendix D were multiplied by a growth factor for the 1976 to 1990 period determined by the method described below.

Minor Sources

The RACT emissions for each process in each plant calculated for the base year by the methods outlined in Appendix D were multiplied by a growth factor for the 1976 to 1990 period determined by the method described below. These were summed over the AQCR.

Stationary Area Sources

This category includes all emission sources listed in Table B-1 except those under the internal combustion heading. Projected emissions were calculated as the product of a projected activity level and an emission factor.

TABLE B-1

AREA SOURCE PROJECTIONS (1)

SOURCE CATEGORY	PROJECTION PARAMETER	PROJECTION SOURCE	GROWTH FACTORS, 1976 TO 1980	1985	1990
Residential Fuel	Households	DVRPC	1.048	1.109	1.171
Comm/Ind. Fuel					
Comm/Inst. Fuel	C/I Emplmt.	DVRPC	1.048	1.109	1.171
Industrial Fuel	Ind. Emplmt.	DVRPC	1.016	1.034	1.049
Incineration	Population	DVRPC	1.020	1.046	1.073
Open Burning	Farm Equipment	DVRPC	1.020	1.046	1.073
Internal Combustion					
Highway Vehicles	FMVCP, VMT	EPA, DVRPC	(See Tables C-1 through C-3)		
Aircraft	LTOs	GC	1.240	1.550	1.86 (0.44)(2)
Vessels	Population	DVRPC	1.020	1.046	1.073
Railroads	Population	DVRPC	1.020	1.046	1.073
Off-Highway Activity					
Farm Equipment	Agri. Emplmt.	DVRPC	0.912	0.829	0.752
Construction Equip.	Constr. Emplmt.	DVRPC	1.021	1.049	1.074
Lawns & Garden Equip.	Population	DVRPC	1.020	1.046	1.073

(1) Representative of the nine-county DVRPC region.

(2) Modified to reflect new aircraft emission standards which are phased in after 1985.

The projected levels of the activity which generates emissions were estimated by assigning a surrogate parameter which would be expected to have a parallel growth rate and for which there were projections of acceptable quality already existing. The surrogate parameter and the source of projection are provided in the table.

In general, the projections of the regional planning group, DVRPC, were used. This, however, necessitated using Salem County and New Castle County data for these county projections or extending the region of applicability. Salem and New Castle County projections were available only for population and some industrial employment categories.

Mobile Sources

Mobile sources, the internal combustion grouping of Table B-1, includes highway and off-highway components. The projected emissions were calculated as the product of a projected activity level and an emission factor. In the case of highway vehicles, the emission factors were also projected by the Federal Motor Vehicle Control Program provided travel characteristics for the region were specified. Activity levels were projected by DVRPC except for Salem and New Castle counties. VMT data for these counties were obtained from the appropriate state transportation department.

The surrogate parameter approach was used for estimating the activity levels of off-highway emission sources, except aircraft. The source of the projection is given in Table B-1. GCA estimates of aircraft landings and takeoffs were used directly. However, they were modified in the 1985 to 1990 interval by phasing in new aircraft emission standards which will reduce emissions by 1990.

GROWTH FACTOR ESTIMATION

Point Sources

Industrial Processes

As mentioned above, projections for point sources should be made on as nearly an individual basis as possible. This is rarely possible and a procedure was established which utilized gross data to establish a context in

which more specific information could be considered. Obers Series E projections for the Philadelphia SMSA and the projections of the Pennsylvania Office of State Planning and Development (OSPD) for the Philadelphia labor market provided the growth factors presented in Table B-2. These factors, for manufacturing earnings and employment by two-digit SIC, were considered to represent the broadest industrial context. Unfortunately, they not only differed according to general level relative to 1976, but they also indicated opposite trends in some instances, such as fabricated metals. Trade journals were consulted for estimates of specific industry activity and in some cases the work of EPA contractors was useful in obtaining specific industry forecasts.

The Penjerdel Corporation, through its Executive Director, Mr. Gardiner Cox, was especially helpful in the effort to obtain industry specific projections. He arranged a meeting between the environmental protection officers of many corporations and Engineering-Science for the purpose of establishing the general economic pictures on an industry by industry basis. He circulated a questionnaire soliciting projection information from about 150 high officials in companies with significant emissions. About 45 to 50 useable responses provided the only industry specific projection information available for the AQCR. The range of projections for the varius SICs for which projection data were received is presented in Table D-3. Also shown is the growth rate adopted after consideration of all the nonobjective, nonspecific data received.

The factors presented in Table B-3 were used in the method described above to calculate emission increments for point sources expected in the 1976 to 1990 interval. New growth, for the NO_x study, was assumed to take place in situ. Alternate growth rates, specifically, the high and low values in Table B-3, were considered in the sensitivity analysis.

Electric Power Generation

The Master Siting Study Report to: Delaware River Basin Commission, June 1975 was consulted. This report has been prepared by representatives of all power generating companies serving the area. It presented the details of all major electric generating projects from 1975 to 1989. This shows that the power demand is expected to double in this interval and the amount of power

TABLE B-2

MANUFACTURING PROJECTIONS

SIC	GROWTH FACTORS, 1976 TO 1980 EARNINGS	1980 EMPLMT.	1985 EARNINGS	1985 EMPLMT.	1990 EARNINGS	1990 EMPLMT.
20XX - Food & kindred products	1.022	0.979	1.071	0.952	1.124	0.927
22XX - Textile mill products	0.870	0.925	0.820	0.846	0.786	0.781
23XX - Apparel & fabric products	0.914	0.990	0.925	0.979	0.952	0.971
24, 25 - Lumber products & furniture	1.040	1.031	1.115	0.036	1.198	1.051
26XX - Paper & allied products	1.101	0.999	1.250	0.991	1.421	0.983
27XX - Printing & publishing	1.104	0.995	1.251	0.974	1.419	0.945
28XX - Chemical & allied products	1.113	0.995	1.297	0.992	1.516	0.994
29XX - Petroleum refining	1.040	0.935	1.098	0.854	1.161	0.788
33XX - Primary metals	1.013	0.988	1.065	0.958	1.125	0.956
34XX - Fabricated metals	1.013	1.004	1.105	0.998	1.216	0.993
35XX - Machinery, excl. electrical	1.010	1.023	1.106	1.048	1.244	1.050
36XX - Electrical machinery	1.098	1.000	1.270	0.990	1.474	0.969
37XX - Transportation equip.	0.792	1.118	0.805	1.251	0.854	1.391
Total manufacturing	1.037	1.005	1.142	1.003	1.266	1.002

Earnings values are based on OBERS Series E projections for the Philadelphia SMSA.

Employment values are based on Pennsylvania OSPD projections for the Philadelphia labor market area in Pennsylvania.

TABLE B-3

SUMMARY OF INDUSTRIAL GROWTH EXPECTED

SOURCE CATEGORY	REPRESENTATIVE SIC's	RANGE OF PROPOSED[1] 1976-90 GROWTH FACTORS	ADOPTED[2] GROWTH FACTORS
BOILERS			
Electric Utility	4911	1.15	1.15
Others			1.15
CHEMICAL MFG.	28XX	1.01-1.64	1.30
	2818	1.00	
	2821	1.00-1.16	
	2834	1.30	
	2899	"decrease"	
OTHER MFG.		1.05-1.50	1.15
IRON & STEEL PRODUCTION	33XX	.97-1.70	1.30
	3312	0.88-1.38	
	3317	"slow growth"	
	3352	0.80	
PETROLEUM REFINING	2911	1.0-1.20	1.15
CLEANING/SOLVENT	7216, 17, 18	1.0-1.50	1.30
SURFACE COATING	26XX	0.87-1.51	1.30
	34XX	0.80-1.40	1.30
PETROLEUM PRODUCT STORAGE	4226, 2911	1.00-1.20	1.15
PRINTING PRESS	27XX	.947-1.51	1.15
PETROLEUM MKT. & TRFR.	4463, 4214	1.00-1.20	1.15
INCINERATION	4953	----	1.15

(1) The highest and lowest values from one or several of the following sources is listed:
Penjerdel; OBERS, Series E, Pa. OPSD; Trade Journals, summaries of specific industry forecasts; DVRPS publications; Master Siting Studies of the Del. River Basin Comm.; and fuel consumption estimates provided by regional air pollution control agencies.

(2) Growth factor of 1.15 signifies a 15 percent growth through 1990 from base year 1976.

generated will also double. The generation requirement will be met primarily by new nuclear facilities at the mouth of the Delaware River and on the upper Schuylkill River. Some new fossil fuel capability will be introduced at the Chester and Eddystone stations where two large coal-burning generators will be installed; however, this increase will be partially offset by retirement of obsolete fossil fueled equipment at nearby sites.

This report was supplemented by fuel consumption estimates prepared for this projection period by the environmental protection officers at the Atlantic City Electric Company and Public Service Electric and Gas Company. These had been prepared for the New Jersey Department of Environmental Protection and represented official projections. Fuel consumption estimates were made for the Philadelphia Electric generating sites based on the proposed schedule of retirements, construction, and changes in ratings given in the DRBC study cited above.

Growth factors for NO_x emissions due to fuel consumption for power generation were estimated in two ways. The total increase in fossil fuel generation capacity for the study period was 10% giving a growth factor of 1.10. The other estimate was based on the direct computation of emissions due to combustion of the estimated fuel requirement in the base year and in 1990. This was preferable to a growth factor derived from the heat content of the fuel required since there were some shifts toward coal and away from distilled oil. The growth in emissions was only 9%, giving a growth factor of 1.09.

A smooth increase over the period was assumed even though two construction steps are detailed in the report: one in 1976, the base year, and the other in 1987-88, toward the study's end. This was because the associated retirement schedule was directly linked to the construction program with the obvious intention of avoiding abrupt changes. However, permitting and/or construction delays could force additional generation of fossil fuel power and probably should be expected. For this reason, the growth factor actually used in this study was 1.15.

Incineration

The amount of material incinerated is a complex function of population, households, and packaging practices. A value of 15% was adopted for the

growth factor from 1976 to 1990 for this source category. This figure is just under the household growth and just under the population factor doubled, which would represent doubling the amount of solid waste produced per person.

Stationary Area Source

Growth factors were established by first updating the growth factors developed for EPA Region III by GCA. Update was required to adjust the base year from 1974 to 1976. It was also necessary to introduce some change in growth rates to correspond with changes accompanying DVRPC's regional development guidelines, which was adopted subsequent to the GCA report. The growth factors resulting are given in Table B-3. These are average factors for the area which differed only slightly from county to county.

Mobile Sources

The vehicle miles travelled projections provided by DVRPC and the New Jersey (Salem County) and Delaware (New Castle County) transportation departments are presented in Table B-4.

RETIREMENT SCHEDULE

Retirement schedules or obsolence data are seldom available from industrial sources. EPA's AQMA guidelines suggests that the number of years allowed by the Interal Revenue Service for depreciation purposes(1) be used. They suggest that if this figure is doubled it will provide an acceptable estimate of the useful life of equipment and facilities. These figures are given in Table B-5 for the industrial categories of major concern.

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(1) Depreciation Guidelines and Rules, U.S. Treasury Dept. IRS. Publication No. 456, Washington, D.C., August 1964

TABLE B-4

PROJECTED VMT IN 1000's/DAY

	1977		1982		1987	
	FRWY	NFRWY	FRWY	NFRWY	FRWY	NFRWY
NEW CASTLE	986	5,589	1,232	6,027	1,429	6,514
BURLINGTON	1,908	3,350	1,989	3,618	2,069	3,886
CAMDEN	1,708	3,721	1,889	3,919	2,071	4,117
GLOUCESTER	1,172	1,543	1,305	1,697	1,438	1,851
MERCER	1,082	2,417	1,160	2,595	1,238	2,772
SALEM	948	1,436	1,018	1,542	1,093	1,656
BUCKS	1,299	4,212	1,396	4,987	1,494	4,761
CHESTER	455	3,685	519	3,975	582	4,264
DELAWARE	605	4,341	664	4,633	722	4,910
MONTGOMERY	1,698	6,474	1,875	6,958	2,053	7,442
PHILADELPHIA	2,304	8,347	2,537	9,505	2,770	10,663
	14,165	45,115	15,583	49,455	16,959	52,836
	59,280		65,038		69,795	

TABLE B-5

ESTIMATED USEFUL LIFE OF VARIOUS FACILITIES AND EQUIPMENT

PROCESS	IRS DEPRECIATION PERIOD (YEARS)	ESTIMATED USEFUL LIFE (YEARS)
Chemical and allied products	11	22
Fabricated metal products	12	24
Motor vehicles and parts	12	24
Paper and allied products	16	32
Petroleum refining	16	32
Petroleum marketing	16	32
Plastic products	11	22
Primary metals	18	36

APPENDIX C

EMISSION INVENTORIES AND METHODOLOGY FOR CALCULATING EMISSION REDUCTIONS

BASE YEAR AND PROJECTED EMISSION INVENTORIES

Source and Quality Data Base

Emission data were obtained with the assistance of Philadelphia Air Management Service, Pennsylvania Department of Environmental Resources, New Jersey Department of Environmental Protection, Delaware Department of Natural Resources and Environmental Control, and EPA Region III. The point source inventories were in four distinct groupings with the following characteristics:

Philadelphia County - Inventory supplied by Philadelphia AMS contained particulate, total hydrocarbon, and nitrogen oxides emission data for 1,022 plants over the period 1971-1976 in NEDS format. Some production information classified as confidential could not be obtained. Major sources are updated annually while minor sources are updated every three years on a rotating basis.

New Castle County - Inventory supplied by Delaware DNREC contained particulate, total hydrocarbon, and nitrogen oxides emission data for 264 plants over the period 1971-1977 in NEDS format. Major sources are updated annually while minor sources are updated every three years on a rotating basis.

New Jersey Counties - Inventories for Burlington, Camden, Gloucester, Mercer, and Salem counties were supplied in NEDS format by New Jersey DEP. These contained particulate, total hydrocarbon, and nitrogen oxides emission data for 148 plants (25, 62, 30, 20, and 11, respectively) for the period 1973-1976 in NEDS format. A recent update of these inventories by ES, under contract to New Jersey DEP, did not complete the updating of all major sources, giving these inventories slightly lesser quality than the preceding.

External Pennsylvania Counties - Inventories for Bucks, Chester, Delaware, and Montgomery counties were supplied by EPA Region III, which had engaged GCA to update these inventories as of 1974. These contained particu-

late emission data for 178 plants (46, 27, 37, and 68, respectively) in NEDS format. These were the least adequate inventories, not only because they represented 1974 conditions, but also because some shortcuts appear to have been taken in developing the inventory, such as grouping processes under one source classification code and omitting stack data or production rate. No hydrocarbon or nitrogen oxides inventories were available for these four counties; however, Pennsylvania DER was in the process of preparing inventories from questionnaires recently provided to industries in these counties. ES generated NEDS inventories based on DER-supplied coding forms in PEDS format for approximately 100 major point source emitters of total hydrocarbons and nitrogen oxides in these four counties. This was 1976 operational data and the inventories should be of high quality.

The only area source inventory for the AQCR which could be found had been prepared by GCA for EPA Region III. This inventory, which contained estimates of particulate, sulfur dioxide, and hydrocarbon emissions in 1974 for each of the 11 counties, was made available and utililzed as a base for this study. Updating to 1976 was required for all sources. Revision of estimates for unpaved roads, construction, open burning, and incineration categories was necessary, as was generation of estimated emissions from structural fires, paved roads, and asphalt paving.

Emissions from highway vehicles were prepared by EPA's CPDD under the guidance of the project officer for this study based upon projections of VMT provided by DVRPC for 1977, 1982, and 1987. DVRPC projections do not include Salem and New Castle counties; however, VMT projections for New Castle County were obtained from Delaware DOT and 1976 link analysis data for Salem was made available by New Jersey DOT. CPDD based Salem's future VMT estimates on the projections for Burlington and Gloucester Counties.

Projection techniques for point and area sources are discussed thoroughly in Appendix B.

Oxides of Nitrogen Emissions - Base Year and Projected

Point Sources

The point source inventory contained estimates of oxides of nitrogen emissions from approximately 1,250 plants. Obvious errors in the inventory were adjusted based on throughput and size. Emissions from major point sources, those with potential of emitting 100 tons per year NO_x in 1976, have been presented in Table III-1. Emissions were organized by source category to facilitate application of control technology (Appendix D) and growth factors (Appendix B). Most of the point source emissions are associated with electricity generation and industrial boilers.

The effect of control technology and the expected growth in emissions during the study period has also been shown in Table III-1. Note that RACT reduces emissions from 155,485 tons per year to 87,762 tons per year; LAER would take it to 58,017 tons per year. Major source growth was found by applying growth factors to the emissions of the individual processes (Appendix B). Note, it was assumed that no minor source will become a major source in the study period, although major sources will have "minor" growth. All major source growth was expected to be at LAER.

Stationary Area Sources

Area sources may be point sources too numerous and small to tabulate; line sources, such as roads which form a network; or areas, such as brush fires. In the case of hydrocarbons, the primary sources are the combustion and evaporation processes. Guidelines for preparing emission inventories on an annual basis at the county level have been prepared by EPA[1] and followed in this study to the degree practicable. The GCA inventory for 1974 prepared for EPA Region III, however, was the basic source of marketing information or activity levels in this study since neither time nor funds could be allocated to basic data collection for this purpose. Of course, when emissions from sources not considered by GCA were estimated, minimal basic information was solicited.

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(1) APTD-1135, June 1972. Guide for Compiling a Comprehensive Emission Inventory, OAQPS, RTP, NC 27711.

The base year and projected area source oxides of nitrogen emissions are presented by source category and by county in Tables C-1 through C-3. Note that emissions total 45,616 tons per year in 1976, or about one-third of the point source emissions; by 1990, they are expected to continue to be about one-third of the point source inventory. The potential for reducing emissions and appropriate control technology is discussed in Appendix C. The projection techniques are discussed in Appendix B.

Mobile Sources

Mobile sources consist of highway vehicles and off-highway vehicles. Separate estimation and projection procedures were used for each.

Highway vehicle emission estimates were prepared by considering basic VMT data provided by DVRPC, Delaware DOT, and New Jersey DOT as mentioned previously. The VMT data provided by DVRPC and Delaware and New Jersey DOT are given in Table B-4. EPA's Mobile I emission factor program was then used to determine nitrogen oxides emissions using national average vehicle mix data and travel weighting factors, average speed data for the two road classes (35 mph on freeway, 15 mph nonfreeway), the hot-cold start percentages used in the Federal Test Procedure, and the appropriate annual temperature and humidity. The product of VMT and the MOBILE I emission factors is presented by county in Tables C-1 through C-3. Note that mobile source emissions comprise 123,879 tons per year or three-fourths of the point source emissions in the base year; with the FMVCP alone, they comprise 82,816 tons per year in 1990 which is a reduction of 33%.

The off-highway segment consisted of railroads, aircraft, river vessels, farm tractors, and heavy construction equipment. These source categories had been included in GCA's area source inventory. Simple updates were made to account for changed activity levels in the later base year, 1976. More extensive revision was required for the projected emissions because DVRPC had modified its projections of surrogate parameters since GCA's inventory was made. These emissions are also presented by county in Tables C-1 through C-3.

TABLE C-1

1976 OXIDES OF NITROGEN EMISSIONS
FROM AREA SOURCES (TONS/YEAR)

SOURCE	NEW CASTLE	BURLINGTON	CAMDEN	GLOUCESTER	MERCER	SALEM	BUCKS	CHESTER	DELAWARE	MONT-GOMERY	PHILA-DELPHIA	REGION
Combustion												
Residential Fuel	910	730	1,235	485	845	175	1,135	790	1,535	1,765	7,300	16,905
Comm/Ind. Fuel	830	880	2,035	335	2,360	145	2,035	1,535	2,535	4,665	11,000	28,355
Open Burning	10	13	2	12	10	15	4	25	2	12	20	125
Incineration	10	8	10	4	8	2	10	8	15	15	50	140
Structural Fires	6	6	8	3	5	1	7	5	10	10	30	91
Subtotal	1,766	1,637	3,290	839	3,118	338	3,191	2,563	4,097	6,467	18,400	45,616
Transportation												
Road Vehicles	10,958	9,101	9,318	4,756	6,000	4,151	9,327	6,850	8,202	13,751	17,965	100,379
Farms & Const. Veh.	550	295	445	170	295	25	825	525	1,100	1,200	3,365	8,795
R.R., A/C, Vessels	745	1,300	915	730	635	330	1,035	645	1,500	1,435	5,435	14,705
Subtotal	12,153	10,696	10,678	5,656	6,930	4,506	11,187	8,020	10,802	16,386	26,765	123,879
TOTAL	13,919	12,333	13,968	6,495	10,048	4,844	14,378	10,583	14,899	22,853	45,165	169,495

TABLE C-2

1980 OXIDES OF NITROGEN EMISSIONS
FROM AREA SOURCES (TONS/YEAR)

SOURCE	NEW CASTLE	BURLINGTON	CAMDEN	GLOUCESTER	MERCER	SALEM	BUCKS	CHESTER	DELAWARE	MONT-GOMERY	PHILA-DELPHIA	REGION
Combustion												
Residential Fuel	930	780	1,300	520	900	180	1,200	830	1,600	1,900	7,500	18,000
Comm/Ind. Fuel	870	920	2,100	360	2,500	150	2,100	1,600	2,600	4,800	11,000	29,000
Open Burning	30	40	6	35	25	45	60	70	4	35	60	410
Incineration	10	9	10	4	8	2	11	8	16	16	52	146
Structural Fires	6	6	8	3	5	1	7	5	10	10	30	91
Subtotal	1,846	1,755	3,424	922	3,438	378	3,378	2,513	4,230	6,761	18,642	47,647
Transportation												
Road Vehicles	9,976	8,482	8,333	4,327	5,369	3,717	8,695	6,168	7,328	12,312	16,536	91,213
Farm & Const. Veh.	530	290	440	170	290	25	800	510	1,100	1,200	3,300	8,700
R.R., A/C, Vessels	820	1,500	950	810	700	350	1,100	660	1,500	1,500	5,700	16,000
Subtotal	11,326	10,272	9,723	5,307	6,359	4,092	10,595	7,338	9,928	15,012	25,536	24,913
TOTAL	13,172	12,027	13,147	6,229	9,797	4,470	13,973	9,851	14,158	21,873	44,178	72,560

TABLE C-3

1990 OXIDES OF NITROGEN EMISSIONS
FROM AREA SOURCES (TONS/YEAR)

SOURCE	NEW CASTLE	BURLINGTON	CAMDEN	GLOUCESTER	MERCER	SALEM	BUCKS	CHESTER	DELAWARE	MONT-GOMERY	PHILA-DELPHIA	TOTAL
Combustion												
Residential Fuel	1,100	900	1,500	600	1,000	210	1,400	940	1,800	2,100	8,000	20,000
Comm/Ind. Fuel	920	1,000	2,300	420	2,700	160	2,200	1,600	2,800	5,100	12,000	31,000
Open Burning	15	30	5	25	20	25	40	55	3	25	45	290
Incineration	10	9	10	5	9	2	11	9	17	17	54	153
Structural Fires	7	7	9	4	6	1	8	5	10	10	30	197
Subtotal	2,052	1,946	3,824	1,054	3,735	398	3,659	2,609	4,630	7,252	20,129	51,640
Transportation												
Road Vehiucles	6,586	4,987	5,196	2,895	3,350	2,354	4,747	3,908	4,492	7,799	11,362	57,616
Farms & Const. Veh.	540	280	430	160	290	25	720	470	990	1,100	3,200	8,200
R.R., A/C, Vessels	890	2,100	1,000	900	860	390	1,200	700	1,500	1,600	6,000	17,000
Subtotal	8,016	7,367	6,726	3,855	4,500	2,769	6,667	5,078	6,982	10,499	20,562	82,862
TOTAL	10,068	8,313	10,550	4,090	8,235	3,167	10,326	7,687	11,612	17,751	40,691	134,456

METHODOLOGY FOR CALCULATING EMISSION REDUCTIONS

Reductions in nitrogen oxides emissions are achieved by the more stringent control technology required by the amendments of 1977. RACT and LAER represent control levels which usually must be specified for each process in each plant; however, more general definitions have been established for the purpose of this study which may be applied to all plants with a common process. These definitions are presented in Appendix D. We are concerned with the method of applying them to the base year point source emission inventory in order to determine the new or resulting emission level.

Three basic inputs are required in order to calculate emissions using the RACT and LAER definitions of Appendix D:

- o production data by process
- o RACT/LAER emission factors and/or control efficiencies
- o actual 1976 emissions and/or control efficiencies

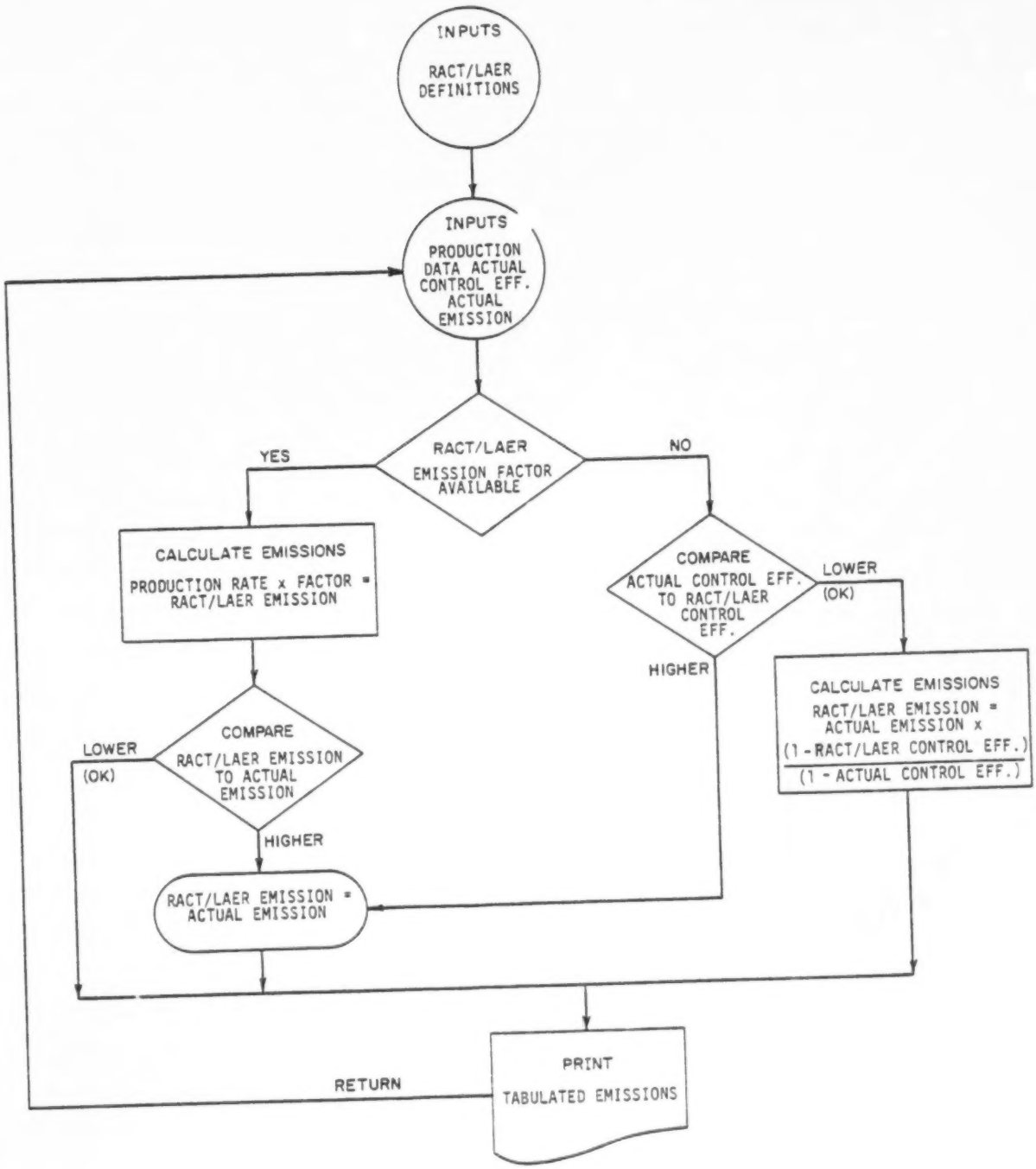
Production data were in general available except when confidentiality was claimed. This was always respected. The emission control definitions for RACT and LAER are presented in Appendix D. These factors are organized by source classification codes (SCC) which correspond to individual industrial processes. The actual emissions were the emissions previously tabulated in this appendix. Thus the necessary input was generally available.

Figure C-1 shows schematically the method used to calculate the reduced emissions. The three fields defined above were the basic inputs. The calculation of emissions as the product of production rate (activity level) and RACT/LAER emission factor was made if possible. The result was compared with the actual emission and accepted as the RACT/LAER emission if it was lower. If it was higher than the actual emission, then the RACT/LAER emission was set equal to the actual emission.

In the event that the RACT/LAER emission factor was not available, the RACT/LAER control efficiency was used. If the RACT/LAER control efficiency was lower than the actual control efficiency, the RACT/LAER emissions were calculated as the product of the actual emissions and the ratio of one minus the RACT/LAER control efficiency to one minus the actual control efficiency.

FIGURE C-1

EMISSION CALCULATION METHODOLOGY (RACT/LAER) FOR PHILADELPHIA AQCR



On the other hand, if RACT/LAER control efficiencies were higher than actual control efficiency, then the RACT/LAER emissions were set equal to the actual emissions.

A computer program was devised to facilitate the handling of the large volume of data associated with calculating emissions under these different circumstances. The calculations were made for each process within a plant for each plant within the AQCR and then summed over the AQCR.

APPENDIX D

EMISSION CONTROL DEFINITIONS

In investigating the effect of various policy options in the attainment of the NO_x standard in the Philadelphia AQCR, the control technologies that could be applied to new and existing stationary sources had to be identified. It was the purpose of this study to test the AQCR-wide effects of various policy options. Hence, it was not appropriate to conduct a detailed examination of the emission characteristics of each plant as probably would be necessary for revision of the State Implementation Plan (SIP). A generalized approach that addressed identical emission processes/sources in the AQCR uniformly as a group was used.

BACKGROUND

Emission Factor Concept

An emission factor relates the quantity of pollutants emitted to some activity indicator such as production or quantity of fuel burned. The factor corresponds to a specific activity but is based on averages for a specific process. As such, the factor does not permit one to estimate emissions accurately from an individual installation but is acceptable when applied to a large number of similar processes, as was done for this analysis.

Sources of Information

Engineering-Science did not conduct original research in developing control technology definitions. Such a task would have required an effort of much greater magnitude than warranted for this study. Instead, control technology definitions already developed in other research efforts were used. Any data deficiencies found to exist after the evaluation of available information were corrected with the aid of EPA's Emission Standards and Engineering Division (ESED). Engineering-Science also visited the ESED offices to discuss the availability of control technology information for specific processes. Approximately 20 ESED staff members provided assistance in areas for which control technology information was lacking or inconsistent.

The control technology references used consisted of documents prepared by EPA's Office of Air Quality Planning and Standards, Emission Standards and Engineering Division (ESED), and by EPA contractors. The ESED publications

were control technology documents (CTD) or standard support documents for various sources of nitrogen oxides. The EPA document, Compilation of Air Pollutant Emission Factors (AP-42), provided control technology data for a wide variety of air pollution sources. Reports from EPA contractors -- Radian Corporation, The Research Corporation, and Houdry Division of Air Products and Chemicals -- provided information for a wide range of processes, including the petrochemical and petroleum industries.

The Project Officer and ESED personnel reviewed the definitions prepared by Engineering-Science. The defininitions were standardized with those obtained in parallel studies for the Houston-Galveston and Chicago areas and missing definitions were provided by ESED. After final review, the Project Officer approved the definitions for use in estimating emissions for the various policy options.

RACT/LAER DEFINITIONS(1)

The control technology that is feasible for a new plant may not be acceptable for an existing plant from an economic or technological standpoint. The new plant technology may involve a process modification or other hardware change that would be difficult or impossible to install at an existing plant. An existing plant may not have the space or structural capability to apply new plant technology. Any number of similar circumstances may prohibit the application of the same technology to both new and existing plants.

Reasonably Available Control Technology (RACT)

RACT is that level of control of existing stationary source emissions that can reasonably be retrofitted to existing processes, taking technological feasibility and cost into account. By law, it is the level of control that the states will adopt in revised implementation plans in 1979 subject to EPA approval. In some instances it will provide solely for attainment of standards by December 31, 1982. In others, it will be more stringent at the state's discretion in order to provide an additional margin for growth. In the case of photochemical oxidants or carbon monoxide, the 1979 RACT SIP revisions may not provide for attainment by 1982. An attainment date extension is permitted until 1987 and the RACT SIP may be submitted in stages with the final submission in 1982.

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(1) It is important to stress that the control technology assumptions are not regulatory and do not relate to any regulatory program development either national or specific to these regions.

Clearly RACT is likely to vary from state to state, from region to region, and even from source to source. This poses a difficult analytical problem in conducting the policy studies. The EPA AQCR studies are, therefore, phased such that while the first phase (this study) does not take cost into account, the second phase will refine some of these assumptions and consider costs. In addition, a range of control assumptions is used to represent RACT, recognizing that RACT is likely to vary and that certain highly efficient emission control technologies are not readily retrofitted to existing sources where less efficient technologies are currently in use.

Lowest Achievable Emission Rate (LAER)

LAER is defined in the 1977 Amendments to the Clean Air Act as the more stringent of the lowest emission rate achieved in practice or the lowest SIP emission limitation achievable for a class or category of sources. It is currently required of all major new or modified sources requesting permission to construct in nonattainment areas. It will continue to be required by all states in nonattainment areas until national ambient air quality standards are achieved and maintained.

Use of Factors

RACT determinations were based on control technologies reported for existing sources and on engineering judgment when control technology found in one of the references was not specifically identified as RACT. The RACT definitions provided herein may not apply to any individual plant because source to source technical and economic characteristics were not considered. In this study, however, no economic factors were considered in defining LAER. When a control technology was not identified in a reference as LAER (or RACT), the technology that allegedly produced the greatest reduction for new sources was adopted.

The RACT and LAER values found in the references took the form of percent reduction of uncontrolled (or partially controlled) emissions or a "controlled" emission factor. If only a percent reduction was provided, a controlled emission factor was, in most cases, calculated by utilizing the percent reduction and the uncontrolled (or partially controlled) emission rate from EPA's Compilation of Air Pollutant Emission Factors, AP-42. EPA is currently in the process of developing generalized RACT guidelines which should be utilized

to assist in the definition of RACT for specific plants or sources. EPA is also conducting studies to coordinate through a central clearinghouse the advances in LAER control technology from all new plants in the United States for future studies.

SUMMARY OF CONTROL TECHNOLOGIES

Engineering-Science prepared tables (located at the end of this section) summarizing control technologies for major industrial processes identified in Appendix C of this report. Each table contains data for a single major industry category as defined by the Source Classification Codes. The sources within the major categories are arranged in alphabetical order according to process description. The Source Classification Code is provided from the current National Emission Data System (NEDS) listing. The process emission units corresponding to the specified emission factors are included in the tables.

Three different emission factors are specified in the tables. The first is the uncontrolled emission factor and, if known, the fugitive portion of the factor. The remainder of the table is devoted to RACT and LAER definitions. For each technology, the applicable abatement method, corresponding controlled emission factor, and data references are specified.

A summary of the control technologies used in this analysis is shown in Table D-1.

TABLE D-1

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NITROGEN OXIDES INDUSTRY EXTERNAL COMBUSTION BOILER

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD (1)	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD (1)	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Electric Generation - Bit. Coal - >100 MMBtu/hr Pulv. Wet	10100201	lb/ton burned	30	Low XS air + SC	25%	22	ESED	Low XS air + SC	25%	22	ESED
Electric Generation - Bit. Coal - >100 MMBtu/hr Pulv. Dry	10100202	lb/ton burned	18	Low XS air + SC	25%	13	ESED	Low XS air + SC	25%	13	ESED
Electric Generation - Bit. Coal - Other/Not Classified	10100299	lb/ton burned	18	Low XS air + SC	25%	13	ESED	Low XS air + SC	25%	13	ESED
Electric Generation - Residual Oil - >100 MMBtu/hr	10100401	lb/10^3 gal burned	105	Low XS air or Low XS air + SC + FGR	20-55%	47-84	ESED	SCR with NH_3 injection	90%	10.5	ESED
Electric Generation - Residual Oil - 10 to 100 MMBtu/hr	10100402	lb/10^3 gal burned	105	Low XS air or Low XS air + SC + FGR	20-55%	47-84	ESED	SCR with NH_3 injection	90%	10.5	ESED
Electric Generation - Natural Gas - >100 MMBtu/hr	10100601	lb/10^6 ft^3 burned	600	Low XS air or Low XS air + FGR	19-79%	126-486	ESED	SCR with NH_3 injection	90%	60	ESED
Industrial Residual Oil - >100 MMBtu/hr	10200401	lb/10^3 gal burned	60	Low XS air or Low XS air + SC + FGR	20-55%	27-48	ESED	SCR with NH_3 injection	90%	6.0	ESED
Industrial Residual Oil - 10 to 100 MMBtu/hr	10200402	lb/10^3 gal burned	60	Low XS air or Low XS air + SC + FGR	20-55%	27-48	ESED	SCR with NH_3 injection	90%	6.0	ESED
Industrial Residual Oil - <10 MMBtu/hr	10200403	lb/10^3 gal burned	60	Low XS air or Low XS air + SC + FGR	20-55%	27-48	ESED	SCR with NH_3 injection	90%	6.0	ESED
Industrial Natural Gas - >100 MMBtu/hr	10200601	lb/10^6 ft^3 burned	600	Low XS air or Low XS air + SC + FGR	19-79%	126-486	ESED	SCR with NH_3 injection	90%	60	ESED
Industrial Natural Gas - 10 to 100 MMBtu/hr	10200602	lb/10^6 ft^3 burned	230	Low XS air or Low XS air + SC + FGR	19-79%	48-186	ESED	SCR with NH_3 injection	90%	23	ESED

(1) Low XS air = low excess air firing; SC = staged combustion; FGR = flue gas recirculation; and SCR = selected catalytic reduction.

TABLE D-1 (cont)

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NITROGEN OXIDES INDUSTRY EXTERNAL COMBUSTION BOILER (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Industrial Process Gas - Refinery >100 MMBtu/hr	10200701	$lb/10^6 ft^3$ burned	600	Low XS air or[1] Low XS air + FGR	19-79%	126-486	ESED	SCR with NH_3 injection[1]	90%	60	ESED
Commercial/Institutional - Residual Oil 10 to 100 MMBtu/hr	10300402	$lb/10^3$ gal burned	60	Low XS air or[1] Low XS air + SC + FGR	20-55%	27-48	ESED	SCR with NH_3 injection[1]	90%	6.0	ESED
Commercial/Institutional - Residual Oil < 10 MMBtu/hr	10300403	$lb/10^3$ gal burned	60	Low XS air or[1] Low XS air + SC + FGR	20-55%	27-48	ESED	SCR with NH_3 injection[1]	90%	6.0	ESED

(1) Low XS air = low excess air firing; SC = staged combustion; FGR = flue gas recirculation; and SCR = selected catalytic reduction.

TABLE D-1 (cont)

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NITROGEN OXIDES INDUSTRY INTERNAL COMBUSTION - ELECTRIC GENERATION

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Distillate Oil Turbine	20100101	lb/10^3 gal Burned	67.8	Water Injection	70-85%	10.2-20.3	Ref. 20	Water Injection	90%	6.8	Ref. 20

TABLE D-1 (cont)

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NITROGEN OXIDES INDUSTRY INDUSTRIAL PROCESS

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Chemical Manufacturing - Nitric Acid Ammonia Oxidation Old	30101301	lb/ton pure acid produced	52.5	Molecular sieve adsorption	93-99%	0.5 - 3.7	Ref. 20	Catalytic combustor	99.8%	0.1	Ref. 20
Primary Metals - Metallurgical Coke Underfire	30300306	lb/ton coal charged			70%		Ref. 20		90%		Ref. 20
Primary Metals - Steel Electric Arc With Lance	30300904	lb/ton produced		none	0%		Ref. 20	none	0%		Ref. 20
Mineral Products - Glass Soda Lime Furnace	30501401	lb/ton glass produced		Temperature reduction	25-67%		Ref. 20	Temperature reduction	67%		Ref. 20
Petroleum Industry - Process Heater - Oil	30600101 & 30600103	lb/10^3BBL oil & lb/10^3 gal oil burned	2900 & 69	None	0%	2900 & 69	ESED	None	0%	2900 & 69	ESED
Petroleum Industry - Process Heater - Gas	30600102 & 30600104	lb/$10^3 ft^3$ & lb/$10^6 ft^3$ burned	0.23 & 230	None	0%	0.23 & 230	ESED	None	0%	0.23 & 230	ESED

TABLE D-1 (cont)

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NITROGEN OXIDES INDUSTRY SOLID WASTE

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Government - Municipal Incinerator Multiple Chamber	50100101	lb/ton burned	2.0	Combustion modification - low excess air	58%	0.84	Ref. 20	Combustion modification - low excess air	63%	0.74	Ref. 20